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MANAGING SASKATCHEWAN RANGELAND

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MANAGING SASKATCHEWAN RANGELAND

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PREFACE

This handbook will interest producers and professionals concerned about the quality and efficiency of rangeland resource management in Saskatchewan. The content emphasizes practical range management information presented in a highly readable format.

The first publication of its kind prepared for Saskatchewan applications, it aims to contribute to the sustainability of the province's rangeland resources.

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MANAGING SASKATCHEWAN RANGELAND

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INTRODUCTION

Planning Importance

Rangeland ranks as a major land type and an important resource on a worldwide basis, whether measured by size, support for animal agriculture or source of water. Thirty percent of the world's land area is grassland, 27 percent is classed as forest and 10 percent is considered cropland.

North America pays a high cost in lost production, damaged watersheds, reduced soil organic matter and lost wildlife habitat due to rangeland misuse. Since rangelands are an ecosystem, agronomic principles applied to management practices have met with limited success.

Range management requires thorough understanding of how ecosystems function.

Efforts to restore grassland productivity and ensure sustainability need to begin with a solid grounding in fundamental ecology. All rangelands respond to plans based on ecological principles.

Rangeland planning is the key to improved and sustainable production of our grazing lands. Through planning, land managers and producers can achieve overall operation improvements.

The Key Steps

Range management planning helps set goals, identify limiting factors and make appropriate adjustments. In doing so, you will examine your operation in-depth and ask questions about past management practices.

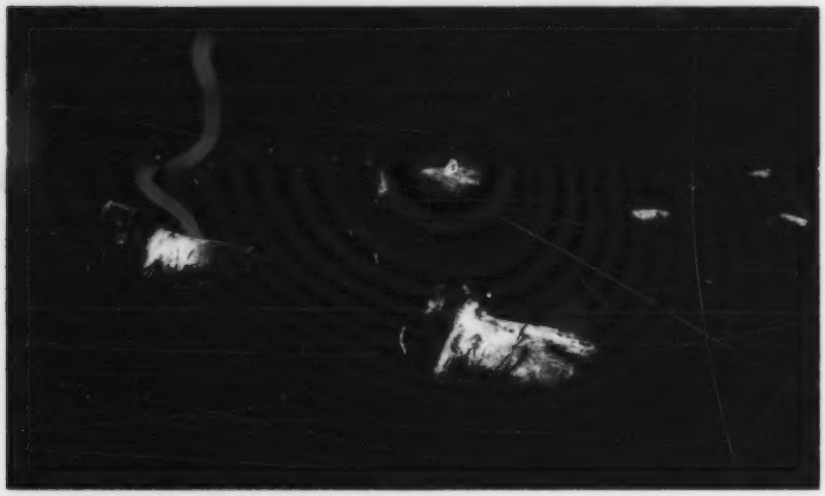
This handbook is an information source designed to help range managers carry out these plans and achieve economic returns.

There are seven key steps to rangeland planning: setting goals, preparing an inventory, problem identification, assessing improvement techniques, implementation, monitoring and goals evaluation.

Goal Setting

Long-term goals help managers decide what is important, the destination, how to get there, and the desired arrival time.

Short-term goals are the means of achieving long-term ones, while making necessary daily and yearly adjustments.



Rangelands respond to effective planning and management.

Assess various improvement techniques to see if they meet your goals.

Planning involves evaluating goals and redefining priorities.

A short-term goal, for example, may be to lengthen the effective grazing season without putting undue pressure on native grass stands. This may be achieved by seeding a complementary annual or perennial forage.

The Inventory

This critical step is discussed in detail in the *Evaluation* section.

Problem Identification

By this stage any shortfalls or problems should be evident. Managers should also know if goals are achievable.

Poor water quality may be one problem which needs to be identified.

If there are problems with pasture and range production, identify them and find solutions. If water is a limiting factor, look at developing new sources. Also answer this question:

- Do I really need more equipment — or would my staff benefit from additional training?

Improvement Techniques

Assess various techniques according to suitability and whether they are ecologically and economically sound. This may mean an improved grazing system, more fencing, additional tame pasture, reseeding, fertilizing, burning, spraying or diversification to different types of livestock.

Base decisions on the merits and shortcomings of each technique and how it fits in with long-term goals.

Implementation

The new plan must be implemented in a logical sequence. Careful planning can save time and money.

Monitoring

A range plan must be monitored to see if desired changes are occurring at the desired rate. This is essential to the planning process because stocking rates fluctuate with yearly weather patterns.

The following questions are important to monitoring a plan.

- Am I seeing positive ecological changes on my land?
- Have I lengthened the grazing season?
- Am I producing more beef per acre?
- Do I have higher weaning weights?
- Am I finding it necessary to cull fewer animals?
- Have my overhead costs gone down?
- Is my quality of life improving?
- Are my employees and family feeling more a part of the operation?

Goals Evaluation

Periodically re-examine goals to see if they need adjustment. Often goals change with time, and what was important last year seems less important now.

GRAZING HISTORY

Before European settlement of what is now the Prairie Provinces, the grasslands were a stable ecosystem. Grazing animals, mainly buffalo but also elk, deer and antelope, were supported by these grasslands and the forest fringe to the north and east.

Herds of elk roamed the Prairies before settlement.

Grazing lands supported a complex of predators and scavengers: grizzly bear, prairie wolf, coyote, kit fox, eagle and crow. They were also home to many other life forms.

Saskatchewan's first ranches were present in the early 1880s.

The interactions within this complex converted the sterile rock particles left by the Ice Age into highly fertile soils.

Buffalo numbers dwindled under settlement pressures. In 1879 extensive prairie fires drove the northern herds deep into Montana where they were hunted to near extinction by buffalo-hide traders. Pressures on elk, antelope and deer populations then intensified, and these too were either driven from the Prairies or greatly reduced in numbers.

Settlement drove bison herds from the grasslands.

Records and diaries from the 1880s show this was a wet period. Prairie grasses, reacting to the combination of moisture and destocking, benefited and grew abundantly. A cyclic climate of several wet years combined with several drier years followed. The destocked range flourished under light use until about 1920 when the source of grazing pressure shifted from wild animals to large numbers of domestic livestock.

The needs of traders, settlers, the North West Mounted Police and builders of the Canadian Pacific Railway had all contributed to this increased attention on livestock production and the West's vast sea of grass.

The construction of the Canadian Pacific Railway also opened up markets in eastern Canada and Europe. Thus began the western Canadian plains ranching era.

Among the large spreads was Alberta's Cochrane Ranch Company, a 100,000 acre property established in 1881. Saskatchewan ranches tended to be smaller, with the Fenton Ranch south of Swift Current among the province's first large operations.

In 1888 a grandiose ranching plan called the 76 was registered. Ten 10,000-acre parcels comprised the 76, which was spread at intervals between Balgonie and Dunmore, near Calgary. The plan included a grain farm at Balgonie, and sheep and cattle farms at Rush Lake, Swift Current, Gull Lake, Crane Lake and Kincorth. Capital shortages, lack of experience and bad luck brought about animal losses from harsh winters and disease, resulting in the final breakup of the 76 in 1909.

Other major Saskatchewan properties of the period included the Turkey Track and the Gull Lake Ranching Company, but directed and funded by absentee owners like most other large ranches, they soon floundered. Although Texas-based, the Matador Ranching Company was longer-lived, due partly to its ranching management experience.

Between 1900 and 1905 at least 25 small ranches were established south of the South Saskatchewan River, mostly by former employees of the larger ranches.

EARLY LAND ADMINISTRATION AND USE

In the early ranching era Saskatchewan rangeland administration was handled by the Government of Canada as part of the area called the Palliser Triangle. Deemed by the early explorer Sir John Palliser to be unfit for farming, this area extended east from the Rockies to Saskatchewan.

At first rangeland was theoretically completely open to purchase, but in practice land tenure existed. In 1881 lease grants of 21 years on areas up to 100,000 acres were authorized. The annual rental was one cent per acre. Settlement and use conditions were specified.

Of note was a stocking requirement of one head of livestock per 10 acres. This later became one head per 20 acres and then one head per 30 acres. Once the stocking level was attained, the lessee could purchase up to five percent of the land at two dollars per acre.

The western land survey was begun in 1871 with the base line being the meridian of longitude immediately west of the Red River settlement boundary. Certain lands remained with the Hudson's Bay Company, two sections were reserved as school properties, large land grants went to the railways to encourage line construction, and homestead rights were made available.

From 1896 to 1914 the Canadian Government allocated millions of acres of homestead land in Saskatchewan. In addition, the railways and large land companies sold millions more acres.

Rangeland purchasing and leasing was well under way when the homesteading rush began in 1896.

As settlement increased regional agriculture was influenced by climate, soil, topography, drainage, transportation and marketing facilities. Generally, the rougher poorer land became pasture, either remaining as large grazing tracts or small areas within or adjacent to croplands.

In addition to sheep and cattle, draft horses were a major user of pastures, increasing to a high of 2,250,000 head in 1926 and declining slowly until 1945 when they started being rapidly replaced by tractors.

PRE-DEPRESSION OVERGRAZING AND RESEARCH

Lease abandonments due to overgrazing were reported as early as 1912. By 1925 rancher groups in southern Alberta were pressing for review of their lease rates, arguing that set carrying capacities could not be achieved.

After meetings between Experimental Farm personnel and representatives of the Stockmens' Associations, a range survey of southern Alberta and southwestern Saskatchewan was undertaken in 1926 by L.B. Thomson and S.E. (Doc) Clarke.

Experiments were started in 1927 on continuous, rotational and deferred grazing systems; cattle behavior as an aid to encouraging grazing; development of stock watering facilities; and reseeding abandoned land. Dr. Clarke studied native grazing; various grazing practice effects; native range improvement by reseeding; surface cultivation and fertilization; and growing cultivated forage crops.

This joint venture between ranchers and scientists became the Manyberries Range Experimental Station. In 1935 Mr. Thomson left Manyberries to direct the Swift Current Experimental Farm, where similar and complementary scientific studies were initiated. Subsequently, grassland research spread to numerous experimental farms, research stations and universities.

Serious overgrazing prompted the start of range utilization research in 1927.

GREAT DEPRESSION CHALLENGES

In 1935 The Land Utilization Act was passed to deal with the problem of farmland abandonment resulting from several drought years, unsuitable agronomic practices and the Great Depression. Carrying out the Act's responsibilities, including controlling soil erosion, was undertaken by the Land Utilization Board. Since the Board lacked the resources to effectively address erosion, the Prairie Farm Rehabilitation Authority (PFRA) was established.

Community pastures offered land abandonment solutions.

The Authority began to tackle the problems of soil erosion, water development and land utilization. By 1937 progress had been made in soil drifting control, and water development expertise had increased. There was not yet, however, a solution to land abandonment.

In 1937 provincial and federal officials held a conference in Regina to seek answers to this problem. Plans were under way to move 100,000 head of southern cattle for which there was no winter feed. It was decided that the federal government would take over these lands and convert them into community pastures operated by the PFRA. By 1942 PFRA administered one million acres of community pastures in Saskatchewan, eventually managing 1.8 million acres.

BEYOND THE CROWN LAND TRANSFER

When the Province of Saskatchewan was formed in 1905, Crown land and mineral resource titles remained with the Canadian Government. In 1930 the remaining titles were transferred to the province, bringing about the formation of a Lands Branch in the Department of Natural Resources. The Branch not only administered unpatented public lands, but also inspected homesteads and issued certificates of title to those meeting cultivation and residency requirements.

Saskatchewan rangeland totals more than 24 million acres.

In 1946 the Lands Branch was transferred to the Department of Agriculture and then to Saskatchewan Rural Development in 1988. Today it administers approximately 6.5 million acres of grazing lands.

Of these, about five million acres are leased to farmers and ranchers, 500,000 acres are allotted to the Prairie Farm Rehabilitation Administration for pasture purposes, and 660,000 acres are leased to grazing associations and cooperatives. Nearly 777,000 acres of grazing lands are managed directly by Lands as community pastures.

While the majority of PFRA pastures are on open prairie, 40 of the 56 provincial properties are aspen grove or bush pastures. In these pastures, large areas are seeded to tame grasses.

On all lands, from the brief era of the open range to the present day, Saskatchewan's grazing history has seen periods of increasing livestock usage followed by years of reduced pressure.

At times the rise in livestock numbers has been based on grazing land base expansion or on increased productivity through improved range and pasture management. Other periods of increased livestock numbers were the product of high beef low grain prices. This unfortunately occurred without equivalent increases in forage productivity and led to the deterioration or destruction of grazing resources.

The information in this handbook provides the foundation for a better awareness of the principles of sustained management of Saskatchewan's more than 24 million acres of grassland and bush pasture resources.

ECOLOGICAL APPROACHES

Range management is applied ecology.

Effective range managers understand ecology, its principles, the interaction of ecosystem components and how management influences them. Desired range management goals are only achieved by applying the principles of ecology. When range management issues or problems are carefully and objectively scrutinized, the solutions always involve these principles.

Ecology is the study of the relationship between organisms and their environment.

Organisms include everything from microbes in the soil, to algae on the soil surface, to plants that provide habitats for various insects and animals, to forage for herbivores. The term also encompasses livestock and their impacts on other animals, plants and soils.

The environment includes the soil and atmosphere in which the organisms thrive.

Together the organization of organisms and their environment is an ecosystem.

An ecosystem consists of producers, consumers and decomposers. *(See Diagram 1.)* Producers are plants that capture the sun's radiant energy through photosynthesis. Consumers then eat this plant material, converting it to products used by other consumers, including people. Decomposers, mainly bacteria and fungi, break down and rearrange organic plant and animal materials, making nutrients available for use again.

Any interruption or reduction in the efficiency of the producer-consumer-decomposer relationship upsets the ecosystem balance, affecting its productivity. For maximum results, producers must first be allowed to capture and convert solar energy at their maximum potential. Without this maximum production, all other ecosystem components function below their potential.

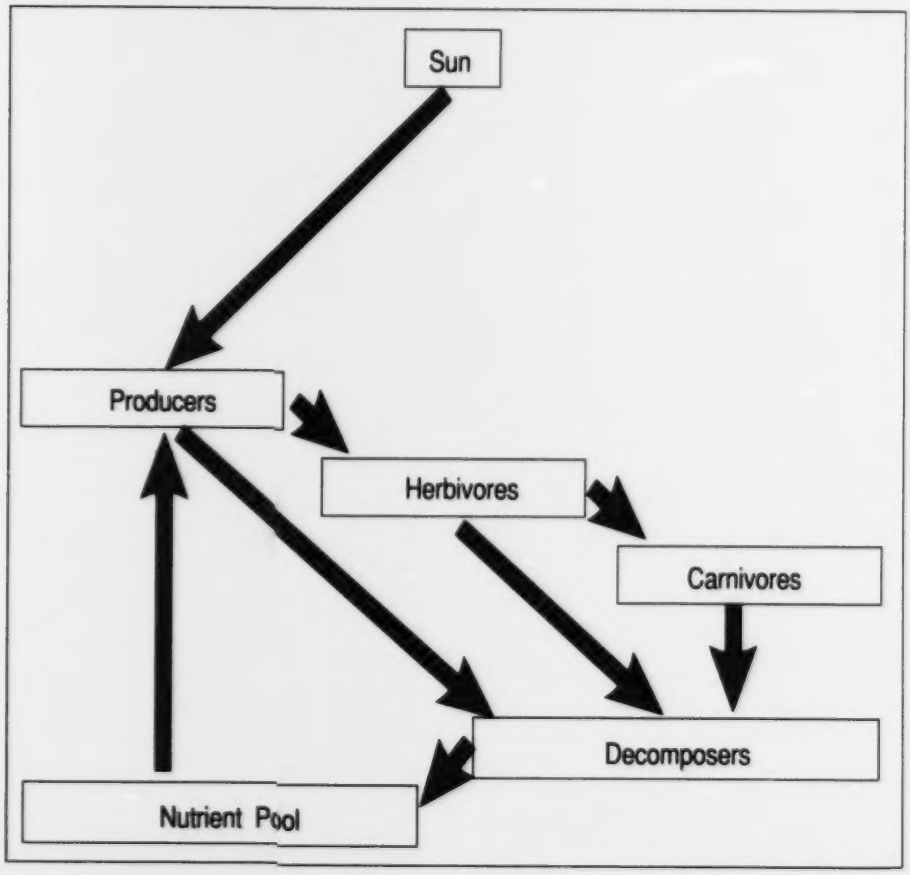


DIAGRAM 1: Simplified Relationships Between Producers, Consumers and Decomposers in an Ecosystem

THE RANGE ECOSYSTEM

Range managers relate ecosystems to the soil-plant-animal complex. This complex develops and functions within environmental limitations. *(See Diagram 2.)*

Many processes operate within each ecosystem component. Water and nutrient cycles constantly function in soils. Photosynthesis, growth, reproduction and death are ongoing in plants.

Diagram 2 illustrates that soils, plants and animals are intimately related. Animal welfare is dependent on plant productivity, while plant vigor is related to soil conditions.

Diagram 2 also shows that the complex is directly or indirectly influenced by management. Every management action affects all components of the soil-plant-animal complex, eventually filtering back to management again. At the same time, functions of the soil-plant-animal system influence management.

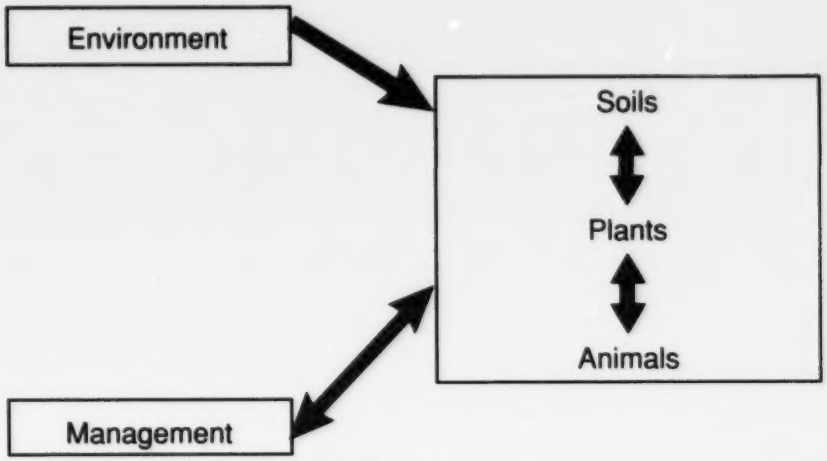


DIAGRAM 2: The Soil-Plant-Animal Complex Model

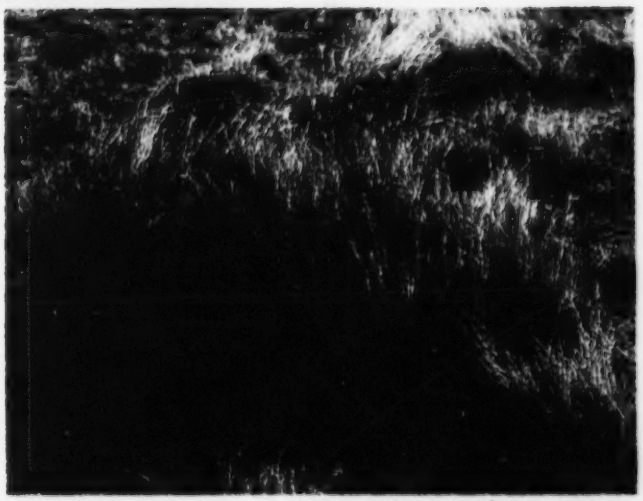
EVALUATING MANAGEMENT FOCUS

Range management often concentrates on animal management, resulting in devastating deterioration of plants, soils and the ecosystem in general. This management philosophy ignores the basic requirements of animal production: healthy soils and plants. End products become the focus, rather than the basic processes and intermediate components essential to producing end results.

The animal management approach also neglects ecosystem aspects important to human welfare, such as water and wildlife. Soil, plants and animals are not isolated components, but interact to form ecosystems which must be managed as units.

To minimize negative effects on all components of the soil-plant-animal system, range managers must develop ecologically based plans.

These plans should consider environmental limitations and be directed at the ecosystem's producers (plants). If this does not happen, an ecosystem functions below its maximum potential with maximum performance and stability in herbivore performance not realized. Eventually these effects ripple back through the soil-plant-animal system, impacting the manager.

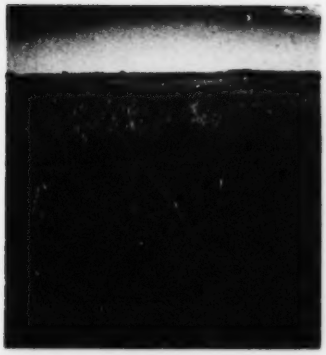


Range management plans must target the producer (plant) portion of the ecosystem.

An inventory of all resources is essential when developing an ecologically based management plan. Knowledge of one's resource base allows charting of management goals and the carrying out of an effective plan. Focusing on goals, it's possible to develop a detailed management strategy directing desired change in the soil-plant-animal complex.

Range managers should not expect immediate success with first attempts to introduce new plans. Evaluate responses of the soil-plant-animal complex and adjust strategy when and where necessary to allow further progress toward the management goal.

Any well-chosen management strategy may cause a positive change in the entire system. Ecologically, management goals should emphasize maximizing ecosystem health over the entire range and sustaining it indefinitely. This also buffers all components of the ecosystem against extremes of weather, insect attacks and other adversities.

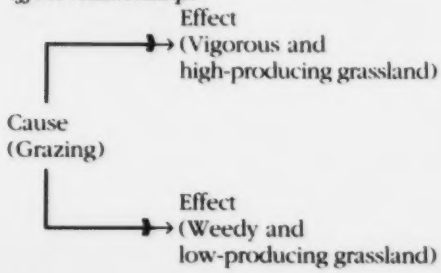


Cause-Effect Relationships

All management activities cause changes in the soil-plant-animal complex. Separating cause-effect relationships from pastureland problems is essential before successful management strategies can be implemented.

Top: vigorous and high-producing grassland.
Above: weedy and low-producing grassland.

The following is one example of a cause-effect relationship.



Weed infestations *(see diagram below)* are often diagnosed as the cause of reduced plant and animal production on poor-condition rangeland. Attempts to solve this reduced productivity through weed control only result in the problem resurfacing again.

The real cause of reduced productivity is never a weed problem. Weeds are a symptom or effect of improper grazing management. Desired forages have been weakened, allowing weeds the chance to grow. Long-term progress will only occur when management is changed to match forage needs.

If a management strategy involves using grazing to alter the soil-plant-animal complex, it can either promote the rangeland ecosystem health and condition or deplete resources. In Saskatchewan's mixed prairie region, for example, grazing can maintain or promote development of high-producing grassland, or cause deterioration and development of a low-producing and frequently drought-stricken range.

Indirect influences can also produce ecosystem responses. Removal of plant litter or dead plant material by grazing of mixed prairie severely reduces productivity. Why this happens is not clearly understood. It may reflect plant environment changes, such as soil and air temperatures, nutrient cycling or the water cycle. Whatever the cause, the productivity reduction indicates a complex ecosystem response to changes.

Often poor management effects are treated rather than correcting the actual cause. Strategies that rely heavily on the repeated use of fertilizers, herbicides and other chemicals, mechanical manipulations such as mowing or seeding, and prescribed fire are usually treating effects of some management shortcoming.

Although poor grazing management is most often the cause of problems, well-planned grazing management provides the most economical and ecologically sound technique to permanently remedy concerns.

Successional Considerations

Whether or not management actions produce the desired results depends on the ecosystem state, the manager's understanding of the soil-plant-animal complex, and the application of ecological principles. When developing a management plan to promote a healthier ecosystem, one must consider individual plant community factors.

Each plant community is unique. It is the product of soils, climate, terrain, kinds and numbers of plants and animals in and around the area, how severely it has been disturbed and past management practices. Since no two plant communities are identical, no two will respond exactly the same to management.

Plant community response to management differs on black versus brown soils. Likewise, management responses in the cooler and moister regions of the province are not the same as in the warmer and drier locales. Also expect varying plant community responses when sheep versus cattle are the primary grazers.

Since every farm or ranch has a great variety of soils, terrain and plant types, specific strategies must be designed for each management unit.

MANAGING DISTURBANCE TO ACHIEVE GOALS

From a range management perspective, it's necessary to understand ecological disturbance. Disturbance, which is defined as forces that alter an existing ecosystem, results from grazing, fertilizers, herbicides, mechanical treatment and prescribed burning.

All management activities disturb the soil-plant-animal complex. This impact has far-reaching effects on rangeland and perennial pastures. While past disturbance determines the present health and composition of an ecosystem, current disturbance will shape its future makeup and productivity.

Management mistakes are immediately visible and expressed as long as it takes the ecosystem to repair itself and move toward maximum production. The farther the ecosystem is out of balance, the longer it will take it to return to a desirable state. This timeframe is greatly influenced by climatic conditions. The return to potential productivity is usually more rapid in years of favorable environmental conditions than in times of less than optimum conditions.

Range management involves applying disturbance or other activities to achieve predetermined goals. A manager can control when, how often, how long and to what degree a disturbance is applied. Tailor these factors to suit the particular ecosystem being treated, the ecosystem's present state, and management objectives. Thus all range management plans must be customized according to the resources, local conditions and the manager's desired goals.

Managers can vary the time, frequency, intensity and duration of disturbance to either encourage or hinder the competitive ability, reproduction and death of a particular species or group of plants. This is done either by directly targeting the plants, or indirectly by changing the soil and/or environment surrounding the plants.

Natural ecosystems tend to respond to disturbance in a way that minimizes effects. This buffering allows the land to adjust and support various plants that are best adapted to thrive under particular combinations of time, frequency, intensity and duration of disturbance.

For example, overgrazing leads to a plant community composed of species that avoid or tolerate grazing pressure through various traits. Another better adapted group of plants will develop if grazing pressure is further increased or relieved.

Controlling range disturbance is an important management consideration.

The specific time that disturbance is applied to an ecosystem is a major management consideration. Soils and plants are more vulnerable to stresses at certain times of the year, growth stages and ages than other periods.

Clay soils are very prone to compaction in spring when they are wet, but this is a minimal problem in late summer when dry. Similarly, depending on the plant species, all are more sensitive to grazing, burning, herbicides and other disturbances at specific growth stages.

Frequency, or how often disturbance is applied, also shapes the outcome in the plant community. Some plant communities require frequent disturbance to be maintained.

For example, there is a natural succession toward forest in the parkland region. If maintaining grassland is the desired goal in this area, relatively frequent disturbance from fires, herbicides, mechanical means or grazing is required for its maintenance. However, too frequent a disturbance of fire or grazing will convert fescue grassland to mixed prairie.

Disturbance duration also induces major ecosystem changes. Plant regrowth differs for grazed species that have endured 30 consecutive days with reduced leaf area than plants that have experienced 10 similar days.

Longer disturbance duration always produces greater changes than a shorter one. This concept is one of the most important grazing management considerations.

Disturbance intensity or severity required to cause a change in the plant community varies, depending on how far it needs to be shifted.

For example, given a tract of rangeland in poor ecological condition, assume stocking rates based on the maximum forage production and a management goal of achieving excellent ecological condition. Attaining a positive change in range condition will likely require major stocking rate adjustments because plant production is much less than its potential. However, if this same range were in good ecological condition, major stocking rate changes would not be required.

PROACTIVE VERSUS REACTIVE MANAGEMENT

Maximizing ecosystem health is essential to achieving production goals.

Range management can be either proactive or reactive. The manager's challenge is to control reactions rather than continually respond to unplanned circumstances. Developing and implementing ecologically based range management allows much greater control, as well as the ability to predict processes and outcomes in the soil-plant-animal complex.

Attempts to maximize livestock production without paying close attention to soils and plants are not effective. Soils and plants are required to support livestock, and not vice versa.

Managing rangelands must be geared toward maximizing ecosystem health. If an ecosystem is properly managed, animal productivity is maximized and sustained. Capitalizing on productivity this way results in more usable outputs and rangeland which provides resources indefinitely.

NATURAL VEGETATION ZONES

Southern Saskatchewan is part of the Great Plains physiographic region. The region's elevation ranges from about 1200 metres in the southwest corner to approximately 240 metres near the Manitoba lowlands. The topography is undulating to rolling, broken by several valleys, escarpments, plateaus and isolated hills.

The region is divided into three prairie steppes by two eastward facing escarpments. The first division from east to west is the Manitoba escarpment. It includes a series of hills ranging from 150 to 300 metres above the Manitoba lowlands, or first prairie steppe. This escarpment is represented by the Pasqua and Porcupine Hills and by the Duck Mountain area.

The second prairie steppe, the Saskatchewan plains, is a large area between 450 and 600 metres above sea level. Lake plains cover much of the area, with local relief and vegetation changing little. Hummocky moraines, sand dunes and deep valleys break up these plains.

Rising 90 to 150 metres above the second prairie steppe is the Coteau du Missouri. The Coteau represents the eastern edge of the Alberta Plateau, or the third prairie steppe. This area is characterized by large rolling hills. Elevation ranges from 550 to 730 metres with local relief up to 70 metres.

Two main climatic types are present in southern Saskatchewan.

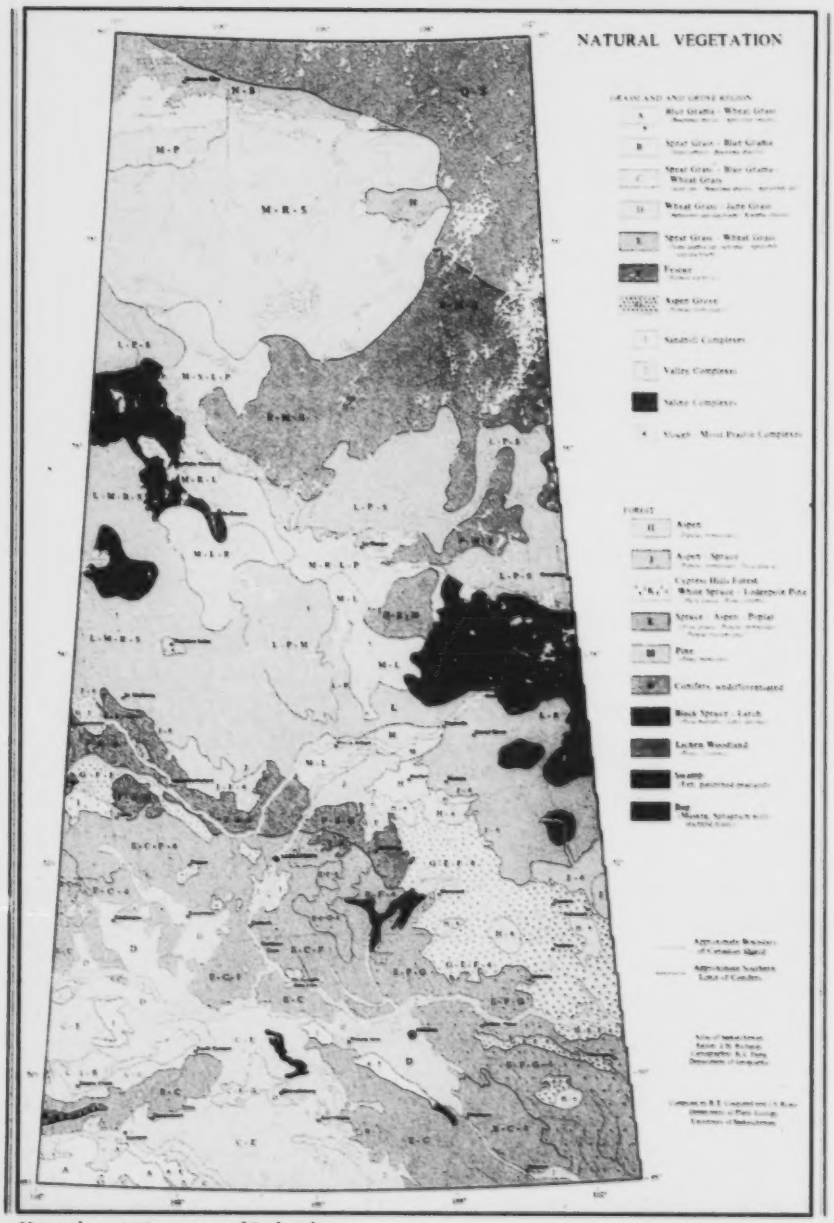
A cold semi-desert climate dominates the southwestern region. Semi-arid conditions prevail since the potential evaporation is greater than the precipitation received. Grassland vegetation and soils are associated with this climate.

A cold forest climate occurs adjacent to the grassland area. Subhumid conditions allow the growth of aspen groves and forest vegetation.

The grassland area is divided into two associations: mixed prairie and fescue prairie. Aspen groves occur in the fescue prairie and in eastern portions of the mixed prairie.

The mixedwood forest lies further north and is comprised primarily of trembling aspen, jack pine and white spruce. Complexes exist in localized areas where environmental conditions cause significant differences in vegetative cover. Sandhill, wetland, valley and saline complexes are the most common.

Saskatchewan's vegetation zones run in belts from southeast to northwest, coinciding with moisture and temperature gradients. Natural vegetation is determined by climate, soil and physiographic features.



Natural vegetation zones of Saskatchewan.

Blue Grama/Wheatgrass

This community is commonly found in the southwestern corner of the province on solonetzic soils. These soils are comprised of thin glacial deposits ranging from light loam to clay loam texture. Modified by underlying shales, the deposits have become relatively impermeable. This characteristic, as well as the proximity of the area to the drier part of the brown soil zone, cause solonetzic soils to have a droughty nature.

Blue grama is the dominant grass over most of the area. The co-dominant western wheatgrass is most prevalent in eroded depressions called "burnouts" or "blowouts". These patches represent a significant area, greater than 15 percent in some locations.

Each of these species contributes about equal amounts to forage yields. However, due to the low growth form of blue grama, it occupies about three to four times the area of western wheatgrass.

Blue grama contributes about 50 percent to the total vegetative cover. Western and northern wheatgrass provide about 15 percent cover.

The proportion of blue grama to western wheatgrass remains relatively stable with abundant moisture and moderate grazing pressure. Periods of drought and/or heavy grazing result in a blue grama increase and a decrease in wheatgrass. This composition change dramatically affects the landscape appearance, with the community taking on a shortgrass look. However, due to past grazing management, the shortgrass vegetation type only occurs in Saskatchewan as a disclimax.

Some other principal grasses and sedges are needle-and-thread, June grass, Sandberg bluegrass, plains reed grass, thread-leaved sedge and low sedge. Loamy sites tend to favor needle-and-thread while eroded sites favor thread-leaved sedge.

Dense club-moss may occupy up to 30 percent of the plant cover.

Forbs and shrubs represent a small part of the total vegetation, with pasture sage the most abundant forb. Prickly-pear cactus and moss phlox are two of the more common forbs. The most prevalent shrub is silver sagebrush.

Winterfat and Nuttal's atriplex, two valuable half shrubs, also occur in the area. These plants can provide late grazing, but require careful management to maintain productivity.

Prickly-pear cactus is common on sandy sites in the blue grama wheatgrass community.

Response to Grazing

Decreasers	Increasers	Invaders
wheatgrasses	blue grama	Russian thistle
needle-and-thread	June grass	cheatgrass
Sandberg bluegrass	plains muhly	
plains reed grass	thread-leaved sedge	
winterfat	pasture sage	
Nuttall's atriplex	prickly-pear cactus	
	moss phlox	
	scarlet mallow	
	dense club-moss	
	everlasting	
	broomweed	

Blue Grama/Needlegrass (Needle-And-Thread)

This community occurs in the drier part of the brown soil zone. Here soils are coarser than those associated with the blue grama/wheatgrass type. Medium-textured soils developed from glacial deposits and coarse-textured soils originating from alluvial deposits characterize this type.

The dry local climate and droughty soils inhibit midgrass growth.

Blue grama is the dominant grass, occupying about three times as much area as needle-and-thread. However, due to the taller growth form of needle-and-thread, it contributes almost as much to total forage yields as blue grama. Together these two grasses represent about 70 percent of the plant cover.

Other principle grasses and sedges in order of importance are low sedge, June grass, northern wheatgrass, western wheatgrass, thread-leaved sedge and porcupine grass. The secondary grasses and sedges are Sandberg bluegrass, plains reed grass, plains muhly and sun-loving sedge. Sand grass and sand dropseed are abundant in localized coarse soil areas.

Dense club-moss is not as abundant as in the blue grama/ wheatgrass type, covering less than 10 percent of the ground surface.

Forbs and shrubs furnish approximately 15 percent of the community's composition. Pasture sage, the principle forb, contributes about 75 percent of this amount. Moss phlox is the second most abundant forb.

Shrubs are more common in this type than the blue grama/wheatgrass community. The most common shrub is silver sagebrush, accounting for 90 percent of this component.

This community, like the blue grama/ wheatgrass type, is incorrectly referred to as a shortgrass prairie. Again, overgrazing reduces midgrasses and increases low-growing grasses and sedges. Productivity declines as the midgrasses disappear, followed by a weed species increase and further reduced forage yields.

Response to Grazing

Decreasers	Increasers	Invaders
needle-and-thread	blue grama	Russian thistle
wheatgrasses	Sandberg bluegrass	others
June grass	plains reed grass	
porcupine grass	plains muhly	
sand dropseed		
sand grass		
thread-leaved sedge		
winterfat	pasture sage	
Nuttall's atriplex	moss phlox	
	dense club-moss	
	scarlet mallow	
	broomweed	
	silver sagebrush	
	rose	
	cactus	

Needlegrass/Blue Grama/Wheatgrass

This community occurs in the brown soil zone and the drier parts of the dark brown soil zone. Associated soils are generally of medium texture, loam to sandy loam, and developed from undifferentiated glacial till.

Needlegrass/blue grama/wheatgrass range.

This type is also found on soils developed from glacial outwash with undulating topography.

Limited areas occur south of the Cypress Hills where glacial deposits are deep enough to prevent modification by the underlying shales.

Two needlegrasses, needle-and-thread and porcupine grass, dominate the community. Needle-and-thread dominates drier sites, while porcupine grass is prevalent on moister sites.

The co-dominant grasses, blue grama and wheatgrass, also share an inverse relationship respecting moisture. Soils which retain moisture well support porcupine grass and wheatgrass, while drier soils support needle-and-thread and blue grama.

In hilly topography, knolls and upper slopes are dominated by blue grama and needle-and-thread. Mid slopes support needle-and-thread, blue grama and

wheatgrass. Porcupine grass and wheatgrass occupy lower slopes.

Annual precipitation variations can dramatically change this community's appearance, with periods of drought causing a shift in species composition. Forbs become very noticeable as the midgrass culms shorten or disappear. Favorable moisture conditions enable midgrasses to flourish, almost entirely masking the forbs.

Needlegrass, the dominant producer, furnishes from 35 to 40 percent of forage yields. Together, needlegrass and the co-dominant grasses and low sedge represent more than 50 percent of the community's composition.

Several other grass species are present in this community.

Northern wheatgrass and June grass are found on moister sites with heavier soils. Coarse-textured soils in the area's drier part favor Sandberg bluegrass and plains reed grass. Plains muhly and thread-leaved sedge are common where erosion has removed part of the A horizon. Species associated with moister more sheltered sites (northern slopes) are rough fescue, Hooker's oatgrass and green needlegrass.

Dense club-moss occupies between five and 10 percent of the soil surface. Pasture sage and moss phlox make up the bulk of the forbs. Some of the more common forbs include scarlet mallow, crocus, goldenrod, broomweed, spiny ironplant, silverleaf psoralea and skeletonweed. Shrubs grow in localized areas where moisture is available. Western snowberry, rose and wolf-willow are the most common, while silver sagebrush occurs in drier areas.

Response to Grazing

Decreasers	Increasers	Invaders
rough fescue	blue grama	Russian thistle
porcupine grass	Sandberg bluegrass	dandelion
western wheatgrass	June grass	Kentucky bluegrass
green needlegrass	plains reed grass	others
northern wheatgrass	plains muhly	
needle-and-thread	sedges	
	pasture sage	
	moss phlox	
	dense club-moss	
	scarlet mallow	
	crocus	
	broomweed	

Wheatgrass/June Grass

This community is located in the moister part of the brown soil zone, as well as the drier part of the dark brown zone. Associated soils are typically uniform lacustrine clays, deposited in glacial lakes.

Due to its high value as crop lands, a large part of this type has been destroyed through cultivation.

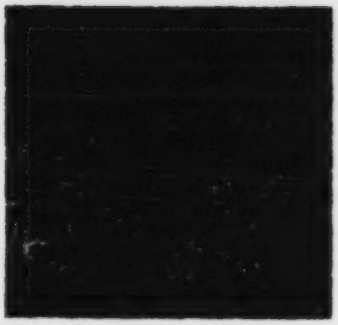
Soils uniformity combined with a low species diversity results in a grassland with a very even appearance. The dominant grasses cover nearly 75 percent of the area. The wheatgrass component alone furnishes almost half the cover, of which over 80 percent is northern wheatgrass.

All species present are midgrasses, with northern wheatgrass the most abundant. June grass occurs more frequently in this type than elsewhere, contributing nearly 25 percent of the cover. Western wheatgrass supplies only five to seven percent of the community's composition.

Green needlegrass, the only other major important grass, represents about 10 percent of the plant cover. Thread-leaved sedge is the only component of the grassland's lower layer, providing between 10 and 15 percent of the cover. Sandberg bluegrass, early bluegrass and plains muhly occur as secondary grasses.

Wheatgrass range in fair condition.

Forbs are less frequent than in any other mixed prairie type. Pasture sage and moss phlox represent approximately 75 percent of the forb component. Other forbs include aster and yarrow. Dense club-moss is not present in any appreciable amount.



Above: wheatgrass range in poor condition.

Like most fine-textured soils, the half shrub winterfat is present.

Overgrazing of this area results in declining amounts of winterfat and invasion by species usually associated with loamy soils. Severe overgrazing eventually leads to a dramatic increase in prickly-pear cactus.

Response to Grazing

Decreasers	Increasers	Invaders
northern wheatgrass	blue grama	
western wheatgrass	June grass	
green needlegrass	Sandberg bluegrass	Russian thistle
	early bluegrass	
porcupine grass	plains muhly	others
	thread-leaved sedge	
	pasture sage	
winterfat	moss phlox	
	aster	
	yarrow	
	everlasting	
	prickly-pear cactus	
	rose	
	silver sagebrush	

Needlegrass/Wheatgrass (Porcupine Grass/Northern Wheatgrass)

Needlegrass/wheatgrass range in excellent condition.

Prior to settlement, this type was the largest grassland association of the mixed prairie. It occurs on brown, dark brown and black soils.

This grassland is found on loamy sites in the moister part of the brown soil zone. It occupies an extensive area of the dark brown soil zone, generally on medium-textured soils. The community occurs in southeastern Saskatchewan on black soils associated with aspen groves.

It tends to be a transition zone between the mixed and fescue prairies. Midgrasses represent from 70 to 80 percent of yields.

Porcupine grass is the dominant species, while northern wheatgrass is the co-dominant. The primary grasses and sedges associated with these two species are needle-and-thread, green needlegrass, western wheatgrass, June grass and thread-leaved sedge.

Rough fescue, awned wheatgrass, slender wheatgrass, early bluegrass and Canada bluegrass are some of the other plants growing in the community. Little bluestem, a warm-season grass associated with the tall-grass prairie, is also present. Blue grama is found locally on exposed slopes and dry soils.

Like other mixed prairie types, pasture sage is the most abundant forb. Moss phlox and dense club-moss are present on drier sites, but are absent from the more favorable areas.

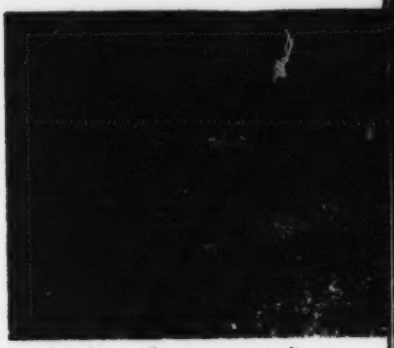
The community's shrubs are similar to those of the needlegrass/blue grama/wheatgrass type, except for silver sagebrush. Western snowberry, rose and wolf-willow are the most common.

Overgrazing of this grassland will initially lead to a reduction in porcupine grass and wheatgrass. Surviving midgrasses, such as needle-and-thread and June grass, remain small and unproductive. Kentucky bluegrass is a common invader of this type's moister areas. Easily recognizable overgrazing indicators are everlasting, yarrow, broomweed and crocus.

Needlegrass/wheatgrass range in poor condition.

Response to Grazing

Decreasers	Increasers	Invaders
porcupine grass	blue grama	Kentucky bluegrass
wheatgrass	June grass	
rough fescue	needle-and-thread	dandelion
green needlegrass	Sandberg bluegrass	Canada thistle
	Canada bluegrass	Russian thistle
	plains muhly	
	little bluestem	
	pasture sage	
	moss phlox	
	dense club-moss	leafy spurge
	everlasting	others
	yarrow	
	western snowberry	
	rose	



Abundance of pasture sage indicates poor range condition.

FESCUE PRAIRIE

Fescue grassland occurs in the black soil zone in western and central Saskatchewan, as well as in the benchlands and upper slopes of the Cypress Hills. The associated soils dark color is the result of an accumulation of organic matter caused by the dominant species, rough fescue.

This grassland's climate has a greater moisture effectiveness (higher precipitation/lower temperatures) than the adjacent mixed prairie.

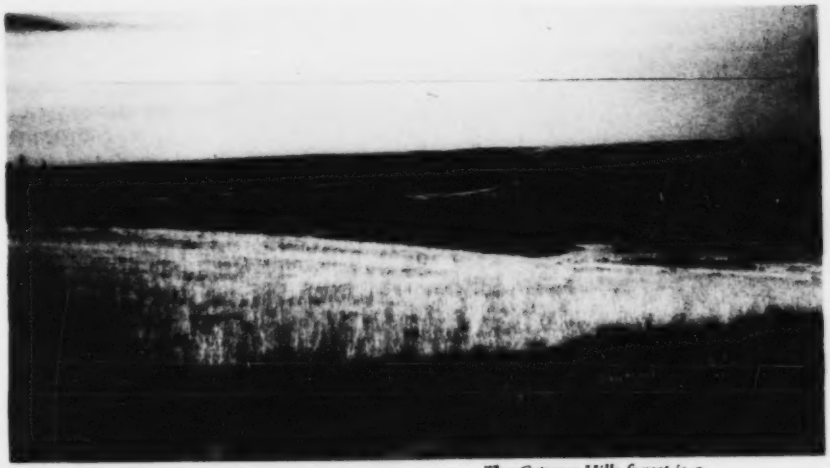
It grows with aspen groves in northern locations and lodgepole pine forests in the Cypress Hills. Rough fescue can comprise up to 90 percent of the cover in some Cypress Hills locations and in more northern parkland areas.

In the Cypress Hills, shrubby cinquefoil is the characteristic shrub. Awned wheatgrass, timber oatgrass, Hooker's oatgrass and porcupine grass are common. Several low-growing sedges occur among these plants, including low, sun-loving and blunt sedge. Secondary grasses are June grass, western and northern wheatgrass and mat muhly. Yarrow, northern bedstraw, violet, crocus, pasture sage and goldenrod are among the more common herbs.

Northern parkland areas are very similar in species composition to the Cypress Hills, except for the absence of shrubby cinquefoil. Further south the relative abundance of rough fescue decreases as porcupine grass increases. The southern part of the region is a transition zone between the fescue and mixed prairies.

Besides rough fescue and porcupine grass, this community's primary parkland grasses are awned and slender wheatgrass, Hooker's oatgrass, low and sun-loving sedge and June grass. Western and northern wheatgrass, plains reed grass, timber oatgrass, little bluestem and blue grasses make up the secondary grasses. The most common herbs are similar to those of the Cypress Hills region. The shrubs rose, western snowberry and wolf-willow occur in localized areas.

Although very productive, rough fescue is very sensitive to overgrazing. Continued heavy use can almost eliminate it from the community, encouraging a noticeable increase in needlegrasses, June grass, blue grama and pasture sage.



The Cypress Hills forest is a lodgepole pine/rough fescue association.

Rough fescue range in excellent condition.

Saline complexes are common in Saskatchewan.

Sandhill complexes consist of active and stabilized dunes.

Response to Grazing

Decreasers	Increasers	Invaders
rough fescue	porcupine grass	smooth brome grass
awned wheatgrass	June grass	Kentucky bluegrass
slender wheatgrass	western wheatgrass	timothy
green needlegrass	needle-and-thread	
Hooker's oatgrass	blue grama	Canada thistle
	pasture sage	dandelion
	yarrow	leafy spurge
	everlasting	

COMPLEXES

Areas occur in most grassland associations where local soils, climate and moisture conditions vary drastically from the norm. The plant cover in these areas often varies more than in the surrounding plant community.

Called complexes, these areas contain plant species that have adapted to local conditions.

Sandhill Complexes

Aridity is the most important factor influencing this area's vegetation survival. Only well-adapted species are present.

Five types of sandhill complexes occur: active complex, stabilized blowouts, stabilized dunes, dune depressions and sand flats.

Active complexes are exposed areas of presently shifting sand. The first plants to colonize these areas have extensive root systems. These "sand binders" thrive on being buried.

Bare sands pioneer grasses include northern wheatgrass, Indian rice grass, sand grass, Canada wildrye and sand dropseed. Lance-leaved psoralea, sunflower, skeleton weed and veined dock act as forb pioneers. Wolf-willow and sand-bar willow are this type's characteristic shrubs.

Stabilized blowouts show signs of recent erosion. Most of the pioneer plants have been replaced by more permanent species like needle-and-thread, June grass, sun-loving sedge, goldenrod and pale comandra. Pioneer plants which typically survive to this succession stage are northern wheatgrass, sand grass and lance-leaved psoralea. Bearberry and creeping juniper are the typical shrubs.

Stabilized dunes show no evidence of recent erosion. Needle-and-thread is the dominant species. Associated grasses and forbs are the previously described "sand binders", and those appearing in the needlegrass/blue grama and needlegrass/blue grama/wheatgrass types.

Dune depressions and sand flats occur between stabilized dunes. Generally the water table is shallow, resulting from abundant shrubs and other woody species. Rose is the most frequently found plant, while wolf-willow, western snowberry and chokecherry are common. Silver sagebrush is the dominant species in the Great Sand Hills. Trees such as willow, trembling aspen and birch exist in locations where moisture is sufficient. Jack pine and white spruce occur in more northern regions.

Saline Complexes

Particularly common in the mixed grass region, saline complexes are generally associated with flat low-lying areas having poor internal drainage. They are also found along watercourses, sloughs and dry lakes. The soils involved are usually alluvial and lacustrine deposits.

The soluble salts concentration and flooding frequency determine the vegetation present. Hydrophytic plants occur on areas experiencing periodic flooding. Halophytic species exist in dry areas where water does not accumulate on the surface. Salinity levels are often lower in the former since periodic flooding flushes salts away.

Distinct vegetation zones are found in saline complexes. In saline sloughs, the deeper depressions that retain water most

of the growing season are dominated by prairie bulrush, sedges and rushes. The highest salt concentration occurs in the adjacent area, which is often bare. Red samphire, sea-blight, saline goosefoot and sea-milkwort can all survive in this region.

The surrounding area is dominated by desert salt grass, foxtail barley, Nuttall's salt-meadowgrass, arrow-grass (poisonous species), alkali cord grass, canby bluegrass and perennial sow-thistle. Also present in less-saline areas are tufted hair grass, slender wheatgrass, western wheatgrass and mat muhly.

The response of these species to grazing varies according to the available moisture. Nuttall's salt-meadow-grass and slender and awned wheatgrass are decreasers at all sites. Western wheatgrass increases on abundant-moisture sites. Mat muhly, canby bluegrass and foxtail barley are increasers.

Continuous heavy grazing leads to a community dominated by foxtail barley.

Wetland Complexes

Most of Saskatchewan's prairie region is dotted with numerous shallow depressions, or sloughs. Sloughs are recharged each spring from adjacent uplands and overflowing streams.

Wetland drainage has a large effect on existing vegetation. Wetlands that do not overflow, or closed drainage basins, tend to accumulate salts and are associated with salt-tolerant vegetation. Overflowing depressions regularly support freshwater vegetation.

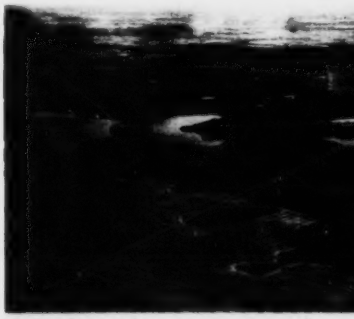
Both freshwater and saline wetlands display distinct vegetation zones as the moisture gradient changes. Cattail dominates freshwater wetlands, while reed grass and bulrush are also common in the deep marsh zone. Shallow marsh regions are often inhabited by creeping spike-rush, awned sedge, whitetop, smartweed, water parsnip, reed canary grass and tall manna grass.

Plants found in the outer margin of the wetlands or wet meadow are marsh reed grass, tufted hair grass, baltic rush, sweet grass and canby bluegrass. These margins are often lined with a shrub fringe, usually willows in the moister areas and western snowberry in the drier regions.

Changing water depth, grazing, mowing and fire are among several factors which can alter vegetation. As the water depth changes the vegetation changes, resulting in some basins being entirely dominated by cattails, bulrushes, whitetop, smartweed or willows. Grazing and mowing encourage spike-rush and whitetop dominance. Burning weakens the emergents and in drier years allows expansion of species like whitetop.

Although wetlands can be very productive in terms of forage yields, careful management is necessary. Since soils are often marginally saline, continuous heavy grazing can change the community composition to one dominated by foxtail barley.

Saline wetlands are characterized by dense stands of coarse emergents like prairie bulrush. The shallow marsh zone contains the greatest salt concentration, supporting only the most salt-tolerant vegetation such as sea-blight, saline goosefoot and sea-milkwort. The outer zone vegetation is the same as found in saline complexes.



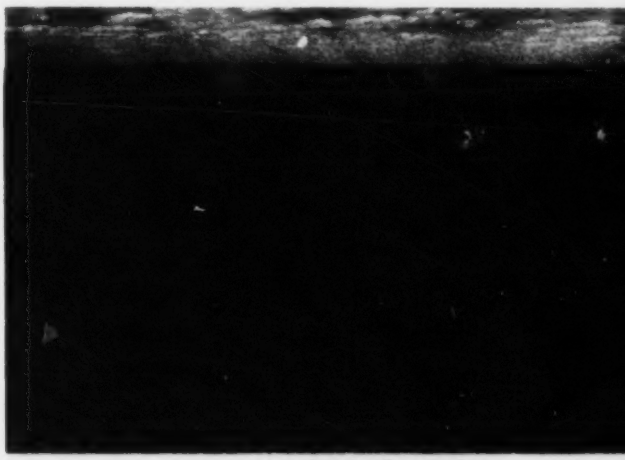
Wetlands provide water, grazing and cover for livestock and wildlife.

Valley Complexes

Glacial drainage channels eroded through the plain provide a range of habitats from badlands to flood plains. Valley vegetation varies with the degree and aspect of slopes and available moisture.

The north-facing slopes provide more favorable growing conditions than the prairie above. Species not commonly found in the area can exist on these sheltered slopes. Western snowberry, wolf-willow, willow and aspen are common here.

Southern exposures support drought-tolerant species.



A glacial valley complex.

Valley bottoms are wetland, saline or flood plain complexes. The wetland and saline complexes are similar to those previously described.

Flood plains occur in valleys with a permanent watercourse. Soils in these areas are constantly eroded and deposited. The local vegetation varies with flooding frequency.

Top and above: the aspen parkland is a broad transition zone between the southern grasslands and northern mixed wood forest which supports substantial cattle herds.

Aspen Grove

Aspen groves occupy primarily the black soil zone, extending into the dark brown soil zone in eastern Saskatchewan. Prairie fire suppression through settlement has enhanced the southward invasion of these groves into the grasslands.

Trembling aspen dominates the moist well-drained sites in association with fescue prairie in the west and needlegrass/wheatgrass in the east. Balsam poplar occupies localized areas where moisture is plentiful. A shrub transition zone between the grove and grassland exists, with western snowberry, wolf-willow, rose, raspberry and buffaloberry the most common.

Where trembling aspen dominates, western snowberry, saskatoonberry, beaked hazelnut and chokecherry are the characteristic shrubs. The typical herbs are sarsaparilla, bunchberry, Solomon's-seal and purple oatgrass.

The shrubs associated with balsam poplar on wetter sites are red-osier dogwood, willow and currant. Non-woody plants present include twinflower, horsetail, coltsfoot, bedstraw and bishop's-cap.

Rose, raspberry and honeysuckle are shrubs common to both the trembling aspen and balsam poplar types. Common herbs and grasses include aster, goldenrod, fringed brome, Canada wildrye, bluegrass, early blue violet, wheatgrass and reed grass.

Cypress Hills Forest

A lodgepole pine/rough fescue association, this forest occurs on black and dark brown soils at elevations greater than 900 metres above sea level.

Lodgepole pine and trembling aspen dominate the well-drained upland sites, while white spruce and balsam poplar are common in moist areas. The pine stands' understorey is sparse, with shiny-leaved meadowsweet and bearberry the most common species. A rich understorey occurs where trembling aspen is more abundant.

Rough fescue dominates the well-drained level uplands, with oatgrass and shrubby cinquefoil common. *See Fescue Prairie for more information.*

Moose Mountain Forest

An aspen forest with interspersed wetlands and moist meadows, this area's soils are black and dark grey originating from glacial till.

Trembling aspen dominates the area, with occurrences of birch, balsam poplar and green ash. Willows surround moist low areas. Common understorey species are fringed brome, bluegrass, sarsaparilla, beaked hazelnut, rose, red-osier dogwood, saskatoonberry, gooseberry, raspberry, wolf-willow and western snowberry.

Slough complexes are dominated by sedges, bulrushes, cattails and reed grasses. Grass-covered upland areas are few, with the most common species present being porcupine grass, wheatgrass, rough fescue and needle-and-thread.

Mixedwood Forest

Trees here combine to form a large number of different cover types. These vegetation types and their associated understorey species are best described based on the site moisture regime.

The characteristic forest of the well-drained uplands is a mixture of trembling aspen, birch and white spruce. Trembling aspen is common on sites subjected to frequent fires because it regenerates quickly.

Jack pine dominates well-drained sandy sites and can occur on drier glacial till soils. Balsam fir and balsam poplar exist locally on moist sites. Black spruce and tamarack are found on poorly drained soils.

Rapidly Drained Sites

Associated soils are coarse-textured and developed from glaciofluvial, fluvial-lacustrine or aeolian deposits.

Jack pine dominates most of these sites. Where the jack pine-lichen/bearberry community occurs, the deep canopy and dry conditions exclude almost all vegetation. The ground cover is mainly lichen. The most common low shrub/herb is bearberry.

The white spruce-wheatgrass/bearberry type occurs on finer sands adjacent to aspen groves. This type's generally open canopy creates a favorable environment for many grasses and shrubs. Wheatgrasses and wood bluegrass dominate the understorey, while rough fescue, June grass, Richardson needlegrass and early blue violet commonly occur. The low shrub layer is primarily bearberry. Saskatoonberry is the most common tall shrub.

The aspen-rose/rye grass type occurs on dry sites prone to frequent fires. Prickly rose is the most common low shrub/herb. Hairy wildrye and bearberry frequently occur in the understorey. Other typical species include fireweed, cream-colored vetchling, nodding brome, wild strawberry, dewberry and bunchberry.

Well-Drained Sites

A greater vegetation diversity occurs on these sites than in rapidly drained sites. Although aspen and mixed stands occur, jack pine and white spruce dominate the area.

Soils are mainly derived from glacial till on level to hummocky terrain.

Feather moss is the typical ground cover on areas dominated by jack pine and white spruce (jack pine-bog cranberry/feather moss and white spruce-feather moss types). Bog cranberry and blueberry are common under a relatively open jack pine canopy. In white spruce dominated areas, common plants are twinflower, bunchberry, bishop's-cap, horsetail, dewberry, coltsfoot and nodding brome.

The aspen-hazelnut and white spruce/aspen-bunchberry types are characterized by a dense shrub understorey. Drier sites are dominated by beaked hazelnut, hairy wildrye and sarsaparilla. Better-moisture areas support twinflower, bunchberry, cream-colored vetchling, dewberry, bishop's-cap, coltsfoot, low-bush cranberry, prickly rose and wild strawberry.

Moderately Well-Drained Sites

Jack pine dominated sites such as the jack pine-feather moss/club-moss type generally have a closed canopy. The ground cover is composed primarily of mosses. Few vascular plants are found in the understorey.

The understorey is more diverse where white spruce dominates in white spruce-feather moss and white spruce/aspen-bunchberry/bishop's-cap types. The low shrub/herb layer consists of twinflower, bunchberry, bishop's-cap, horsetail, dewberry, coltsfoot and nodding brome.

Overgrazing can kill aspen.

The aspen-sarsaparilla/twinflower type occurs on hummocky terrain of moderately coarse to moderately fine-textured glacial till. Several understorey species occur in this type. The most common are sarsaparilla, twinflower, bunchberry, cream-colored vetchling, dewberry, prickly rose, low-bush cranberry and red currant. Other species include coltsfoot, bishop's-cap, bog cranberry, wild strawberry and marsh reed grass in moister sites.

Hedysarum is a native legume of the aspen parkland.

Imperfectly Drained and Poorly Drained Sites

Few understorey species occur due to the dense canopy cover in these sites. This factor and the boggy soils impose severe limitations on the value of grazing these areas with domestic livestock.

Plants present where the canopy is more open are bishop's-cap, bog cranberry, Labrador tea, scouring rush, bunchberry, twinflower and coltsfoot.

Those species found on very moist sites are horsetail, sedges, marsh reed grass, round-leaved orchid, enchanter's nightshade, river alder and swamp birch.

Bush pasture.

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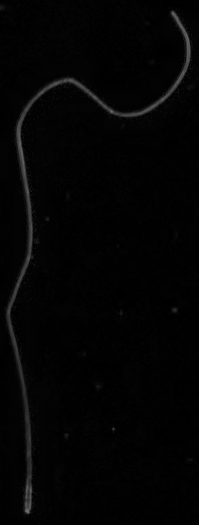
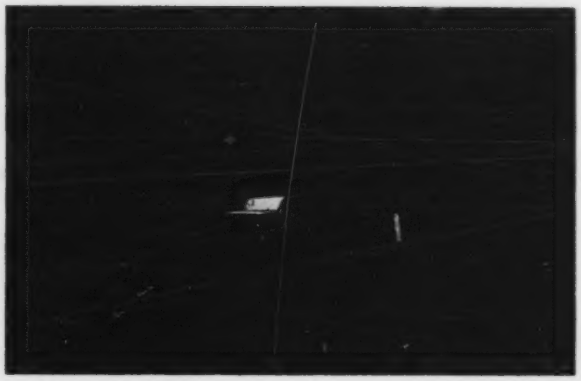


RANGE PLANTS

Learning to recognize range plants and their role in the ecosystem is a cornerstone of good range management. More than 1500 species of native plants have been identified in the Prairie provinces.

All range plants are valuable. They provide habitat for wildlife, stabilize watersheds, protect soil and enhance landscape beauty. Few species are abundant, and even fewer are considered important livestock forage.



Learning to identify plants using a plant key.

There are three ways to learn plant identification — asking someone who knows, comparing specimens to labelled collections and using a plant key.

Visiting the field with a trained person is the most direct method.

Gathering specimens for comparison with known samples provides not only plant names but a permanent collection that can be referred to year after year. Dried plant collections (herbariums) are located at the University of Saskatchewan, the University of Regina and Agriculture Canada research stations.

Several plant keys are available to help identify plants using both vegetative and reproductive parts. The use of a plant key is discussed later, while several helpful related publications are listed at the end of the chapter.

Categories

Range plants are categorized by life form, life span, origin, growth season and response to grazing.

Life Form

Four broad groups of range plants are easily recognized: forbs, shrubs, grass-like plants and grasses. *(See Diagram 3.)*

Forbs have non-woody stems and broad leaves with net-like veins. They are herbaceous and generally die back every winter. Many colorful wildflowers belong to this group. Dandelion, golden bean and yarrow are examples.

Shrubs resemble trees, but have no definite trunk. They are woody plants that live over winter and branch out from near the base. Shrub leaves are broad and net-veined, usually falling off with winter. Rose and snowberry are examples.

Grasslike plants resemble grasses, but have solid stems which are either three-sided (sedges) or round (rushes). They have no visible stem joints and their leaves display parallel veins. Sedge leaves are three-ranked, while rushes have two-ranked leaves. Male and female floral parts are usually found in separate florets. Baltic rush and sun loving sedge are examples.

Grasses have jointed stems which are usually hollow. Their slender leaves, which display parallel veins, alternate in two rows on the stem. They have small green flowers that are usually complete, with male and female parts present in the same flower. Rough fescue, northern wheatgrass and needle-and-thread are examples.

Life Span

Perennials live three or more years, biennials two years, and annuals one year or less. Shrubs and trees are always perennials. Grasses, sedges and rushes are mostly perennials or annuals, while few are biennials.

Origin

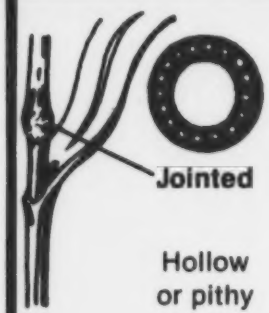
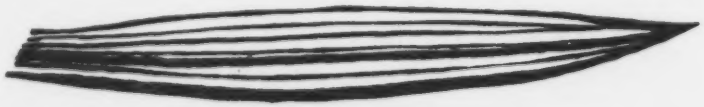
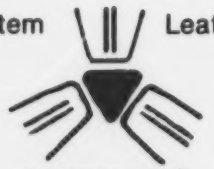
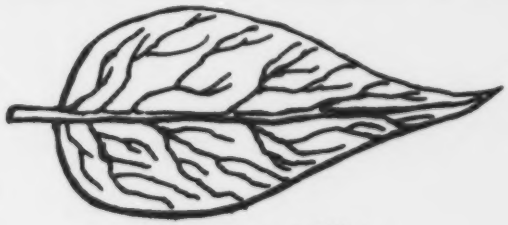
Plants are either native or introduced. Most range plants are native, originating in North America.

Introduced plants are brought into North America from another continent. Most seeded pastures contain introduced species. The majority are valuable forage plants, but some have become troublesome weeds.

Growth Season

Cool-season plants display principle growth in spring before warm temperatures. They may grow again in fall if moisture is available. Cool-season plants produce most of the forage in Saskatchewan.

Warm-season plants begin growth when soil temperatures rise in late spring, displaying principle growth in summer. They are well-adapted to warm exposures and droughty soils, where they photosynthesize at higher temperatures than cool-season plants. There are only a few warm-season species in the province and they contribute less to total yields.

	Grasses	Grasslike		Forbs	Shrubs
		Sedges	Rushes		
STEMS	 Jointed Hollow or pithy		 Solid not jointed	 Solid	Growth rings Solid
LEAVES	 Veins are parallel Stem Leaf Leaves on 2 sides of stem	Stem Leaf  Leaves on 3 sides of stem	Stem Leaf Leaves on 2 sides of stem; rounded	 Veins are netlike	

Response to Grazing

Plant response to specific types of stress varies according to palatability, growth season and form. Three categories reflect the relative response of plants to grazing.

1. Decreasers are palatable, productive plants found in climax communities. They decrease in relative abundance under prolonged, excessive grazing pressure.

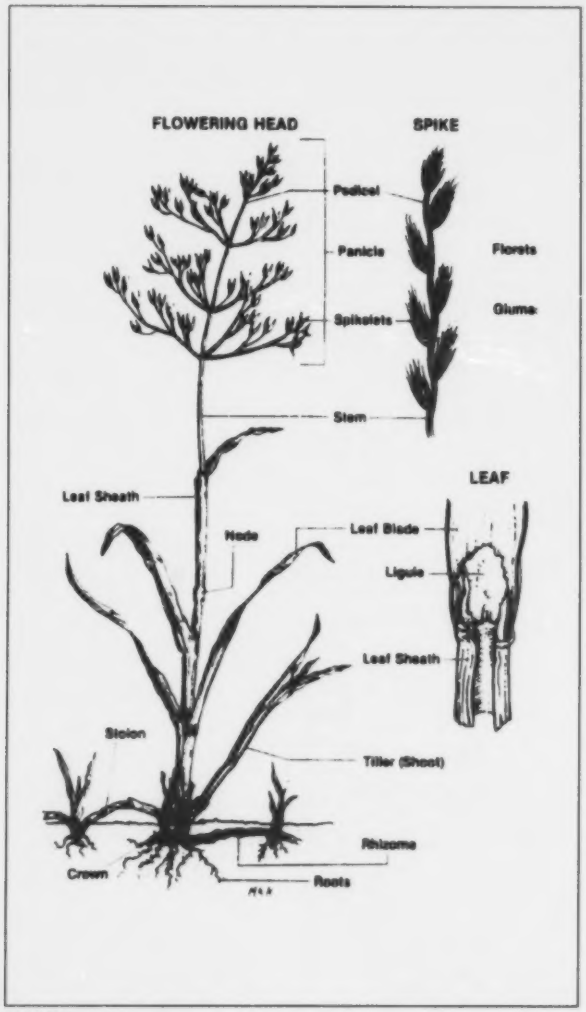


DIAGRAM 4: Grass Parts

2. Increasers are usually shorter, less productive and less palatable plants. They initially increase in relative abundance under grazing pressure, taking the place of decreasers that have died or weakened. As pressure continues, increasers also disappear.

3. Invaders are not normally part of the plant community. They move in and fill voids left when decreasers and increasers die out. Some are annual weeds, others are herbaceous perennials or shrubs. Invaders usually have little or no forage value.

Grazing response is not always the same for a species, but can vary with range site and plant community.

Characteristics

Basic Parts

The basic parts of any plant are the roots, crown, stem, leaves and flowers. *(See Diagram 4.)*

Roots anchor the plant and supply water and nutrients from the soil. The crown is near the soil surface and produces new roots and shoots. The stem gives the plant support and form, and transports water, nutrients and carbohydrates. Leaves manufacture foods by photosynthesis and flowers produce seed.

Plant parts have distinctive shapes, sizes and textures which differ according to the species. A magnifying glass is often needed to examine these parts, but plant recognition is simple once one becomes familiar with the various components.

Grasses

All grasses look alike to the casual observer. However, grass plants have characteristics that set them apart as individuals or species.

To identify grasses one needs to look closely at differences in height, leaf shape, stems, hairiness and seedhead.

Clues to grass identification exist below ground as well. The type of root system and whether rhizomes (underground stems) are present or not can help in identification. *(See Diagram 5.)*

The visible parts of the grass plant are divided into two categories: flowering and vegetative.

Flowering parts, known as the inflorescence, include the seeds and all their appendages. There are three main types of grass inflorescence: panicle, raceme and spike. The inflorescence contains smaller units called spikelets.

The panicle is the most common type of inflorescence. Spikelets are borne on branched stalks (pedicels). The panicle can be closed or spreading. Kentucky bluegrass and needlegrasses have panicles.

A raceme has spikelets borne on pedicels attached to the main axis. Little bluestem has a raceme inflorescence.

A spike has its floral parts attached directly to the main axis or rachis. Wheatgrasses and blue grama grass have spikes.

Spikelets are composed of florets or grass flowers. The grass flower is not showy or colored, and has no scent since it is wind pollinated and does not need to attract insects. The number of florets in a single spikelet varies from one, as in tickle grass, to 30 or more. At maturity each floret produces a seed. *(See Diagrams 6 and 7.)*

Each seed is surrounded by two leaflike bracts called the lemma and the palea. The lemma is bigger than the palea. Sometimes these bracts have hairs that allow the seed to cling to clothing or livestock.

Often florets have sharp projections called awns which help the seed transport itself or 'dig' itself into the ground.

Vegetative parts include stems and leaves. Grass stems are hollow, jointed and compressed or round. The joints, called nodes, are usually swollen. A leaf originates at each node.

Leaves alternate on opposite sides of the stem. Leaves have two parts, the blade and the sheath.

The blade is the portion that extends away from the stem. Leaf blades have distinctive shapes and textures which help identify the species. The sheath is the portion wrapped around the stem. *(See Diagram 8.)*

The point where the sheath and blade join is called the collar. Here a small membrane-like projection, the ligule, extends from the sheath. In some species the ligule is a tuft of hair, or it may be absent. Fingerlike appendages, or auricles, may also wrap around the stem at the collar.

Flowering Plants

Shrubs and forbs with visible flowers are usually easier to identify than grasses. Color and shape of the flowers, as well as leaf and growth characteristics, are often sufficient for identification.

Typical parts of a complete flower are arranged in a circle. The most colorful and conspicuous ring is the corolla, which consists of segments called petals. Below the corolla is a ring of cuplike sepals, known as the calyx. The calyx is usually green and protects or encloses the bud petals.

The calyx and corolla surround the male reproductive organs (stamens) and the female reproductive organ (pistil).

Leaves of broadleaved range plants are deciduous, falling off at the end of the growing season, or evergreen.

Leaf arrangement on the stem characterizes a species. An opposite arrangement refers to leaves growing opposite to each other at a node. An alternate arrangement has only one leaf per node, on opposite sides of the stem. If leaves are whorled, there are three or more leaves growing at one node. *(See Diagram 9.)*

Leaves are simple or compound. A simple leaf has only one definite segment between the stem and the blade end. A compound leaf has definite and distinctive segments, or leaflets. They may be pinnately (featherlike) or palmately (hand-shaped) compound. *(See Diagrams 10 and 11.)*

The size, shape, color, hairiness and vein arrangement (venation) of a leaf blade are characteristics to look for when identifying plants.

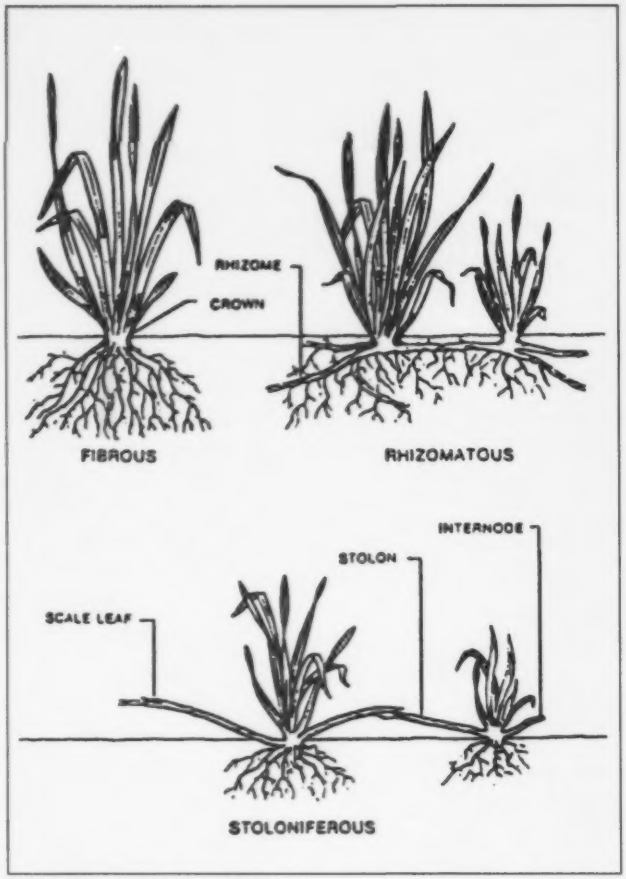


DIAGRAM 5: Types of Grass Roots

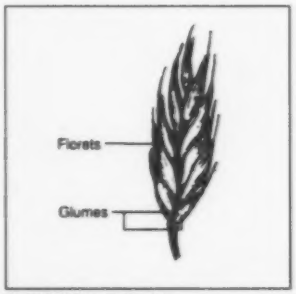


DIAGRAM 6: Spikelet

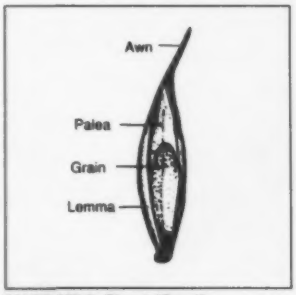


DIAGRAM 7: Floret (Seed)

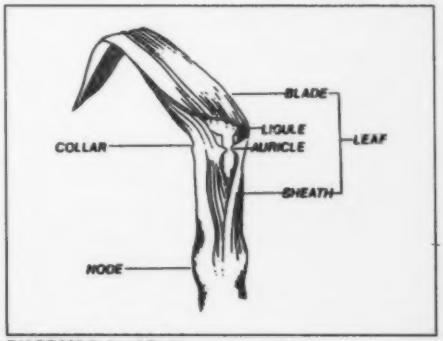


DIAGRAM 8: Leaf Parts

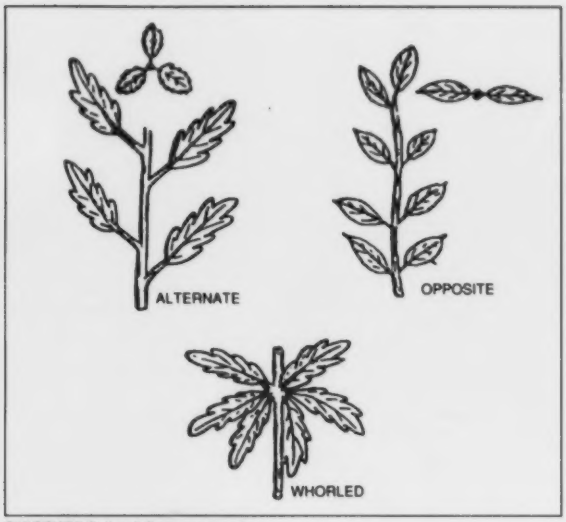


DIAGRAM 9: Leaf Arrangements

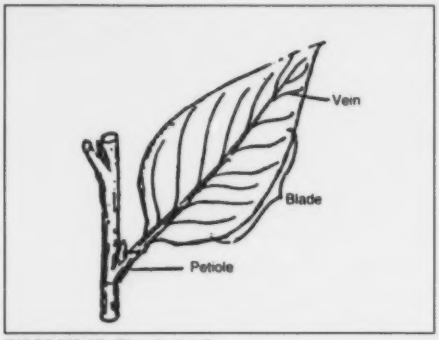


DIAGRAM 10: Simple Leaf

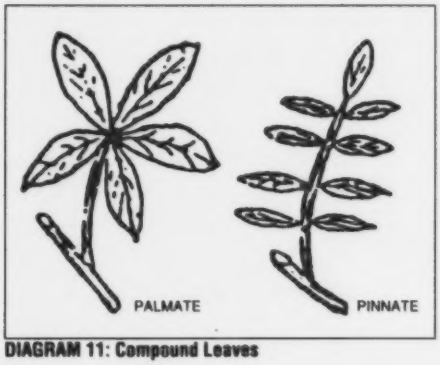


DIAGRAM 11: Compound Leaves

Names

All plants have scientific (botanical) names and usually a common name.

A plant has only one correct botanical name, but may have several common localized names. Botanical names allow universal reference to a particular species without any confusion.

Plants are classified into families, genera, species and sometimes subspecies, or varieties. Each plant's botanical name reflects its genus and species.

Examples of three common plant families and some members follow:

Family	Tribe	Genus	Species	Common Name
Poaceae (grass)	Triticeae	Agropyron	smithii	western wheatgrass
		Agropyron	cristatum	crested wheatgrass
	Stipeae	Stipa	comata	needle-and-thread
Rosaceae (rose)		Rosa	woodsii	wild rose
		Prunus	virginiana	chokecherry
Fabaceae (legume)		Medicago	sativa	alfalfa
		Oxytropis	campestris	locoweed

Collections

One of the best ways to learn to identify plants is to collect, press and name them for reference year after year. Such a collection is a natural library of the species in a pasture.

Plants can be collected and pressed when the opportunity occurs and identified at a later date.

Plants should be gathered when they are nearing maturity, but before they begin to dry out and lose color. Select an average plant that is a representative sample, or collect several specimens showing the range of variation.

Each specimen should include some of the root system, flowering parts and fruit. Collecting flowers and fruit may require more than one specimen. Since plants differ in their growth seasons, collecting specimens may last from May until August.

Soon after every field trip, remove any root soil and arrange each specimen between newspapers or blotting paper. (Wilted or dried plants do not press well.) Fold large plants to fit your equipment, making sure to display all parts. Include a note detailing collection date and site.

When secure between the papers, place specimens in a plant press. Commercial models are available, but two pieces of plywood bound together with straps work well.

Most plants dry within a week and can then be glued to a permanent background. Herbarium collections use background sheets.

Choose a convenient size suited to your purposes. Once the plant is affixed to its background, label the specimen for future use.

Keys

A plant key is a series of alternative statements about the structure and appearance of a plant. Using a key requires a working knowledge of plant part terminology.

Think of a plant key in terms of travelling a road that is a series of well-marked Y intersections.

From each pair of statements in the key, first choose the one that applies to the plant in question. Then proceed to the next appropriate pair and so on until the specimen is identified.

Two opposing characteristics are always given. Always choose the one that best describes the specimen.

Some tools for plant collecting: shovel, hat, press.

Read to the end of the line to determine the next set of characteristics or the name of the plant.

Do not skip down the key. Take each contrasting pair of statements in order. When a specific name for the specimen is pinpointed, check the selection with the description and illustration in the text.

A specimen used for keying should have all its parts if possible, including roots, stem leaves, flowers and fruit. While plant keys rely heavily on reproductive parts, some keys identify common grasses by vegetative characteristics. *(See Diagram 12.)*

If sheath is split down front, go to paired statement 2.

If grass sheath is closed down the front, this would be your answer. No need to go further.

Paired True and False Statements:

1. Sheath split and/or overlapping . . . . . 2←
1. Sheath not split, notched near top . . . . . Downy Brome←

2. Auricles present . . . . . Western Wheatgrass
2. Auricles absent . . . . . Go to paired statement 3

3. Leaves folded in shoot at emergence . . . . . Go to paired statement 4
3. Leaves rolled in shoot at emergence . . . . . Go to paired statement 5

4. Ligule membranous, fringed with coarse hair on margin . . . . . Prairie June Grass
4. Ligule a fringe of hair . . . . . Inland Saltgrass

5. Ligule membranous, very conspicuous, split or fringed, to 4 mm long . . . . . Needle-and-Thread
5. Ligule a dense fringe of hair, less than 0.5 mm long . . . . . Blue Grama

DIAGRAM 12: Vegetative Key For Six Common Grasses

Converting raw materials to salable product is the stockgrower's business.

Grass is the stockgrower's crop. Livestock, the salable product, are simply a means of harvesting that crop.

An understanding of plant growth is the key to successful livestock production. Only then can grazing animals be used to manipulate grass crops to achieve production goals.

Grazing management practices are based on knowledge of plant physiology and morphology. Both physiological (internal chemical) changes and morphological (external structural) changes affect forage quality, quantity and/or survival of the plant.

Physiology

Photosynthesis

Photosynthesis is the basic reaction in green plants that converts solar energy to chemical energy. *(See Diagram 13.)* It provides the energy for plant growth and maintenance. In fact, this reaction is directly or indirectly responsible for all life on earth.

Water and nutrients are taken from the soil through the roots. Carbon dioxide gas enters the plant through holes (stomata) in the leaf surface. Using sunlight energy, carbon, hydrogen and oxygen are combined to form carbohydrates.

The chemical pathway is very complex, but the end result is a usable form of energy, or 'food'.

Carbohydrate energy is used in combination with minerals from the soil to form protein, lignin, fats and plant oils. Plants use these building blocks for growth and maintenance.

Carbohydrate Production and Use

Carbohydrate manufacture, storage and use can be thought of as a factory, a warehouse and a consumer outlet. They interact as follows:

• when the factory (green cells in leaves and stems) produces more carbohydrate than is needed for growth and maintenance, some of the production is shipped directly (translocated) to the warehouse to be stored as starches for future use. Cells produce only during daylight hours in the growing season.

• when factory production is insufficient to meet growth and maintenance demands, current factory output is shipped directly to the consumer outlet as simple sugars. Carbohydrates are also taken from storage to meet the growth demand. Plants can convert between the starch or sugar carbohydrate form quickly and easily according to need.

Growth always has priority over storage for carbohydrate use. There is a hierarchy for growth use.

Newly forming leaves at the growing point come first. Next in line are root growth, stem elongation, tillering and rhizome production. When flowering begins, the reproductive functions are given priority over other carbohydrate uses.

Carbohydrate storage organs include stem crowns, rhizomes and/or stolons. Bunch grasses, such as crested wheatgrass or green needlegrass, store carbohydrates in slightly thickened stem bases. Creeping rooted grasses, like smooth bromegrass or western wheatgrass, have additional storage organs — the rhizomes by which these grasses spread.

$$\text{Carbon Dioxide } (CO_2) + \text{Water } (H_2O) \xrightarrow[\text{green plant material}]{\text{sunlight}} \text{Carbohydrate (food)} + \text{Oxygen } (O_2)$$

DIAGRAM 13: Photosynthesis

Carbohydrate Cycle

An undisturbed perennial plant has a definite yearly cycle of carbohydrate manufacture, use and storage. *(See Diagram 14.)*

Starting in the fall with high levels of stored carbohydrate, reserves are gradually called on during the winter to maintain dormant cells and tissues. When temperatures warm up in the spring, there is little or no green leaf area to produce energy directly, so more stored carbohydrate is used to initiate and expand new leaf area.

As a result reserves drop dramatically in the spring until the plant has produced enough leaf area to meet growth demands. As leaf area continues to expand during the growing season, reserves are gradually built up, until flowering and seed formation draw them down temporarily.

Reserves rise once again in the August to September period in preparation for winter dormancy.

Grazing and Carbohydrate Levels

When productive top growth is removed through grazing, the plant has no factory. It relies on stored carbohydrates to produce new leaf area. Reserve levels drop, and root growth and all other growth functions stop or slow until leaf area is restored.

Uncontrolled grazing can completely deplete a plant's stored carbohydrates, ultimately leading to its death. Particular attention must be paid to severe defoliation during spring and fall.

If the plant is grazed during spring growth before it has produced enough leaf area to obtain a positive carbohydrate balance, stored carbohydrates are quickly depleted. On prairie vegetation, native forage yield increases the longer grazing is delayed in May and June. Tests in which vegetation was clipped starting in late April, late May or June showed that yield was highest when clipping was delayed until late June. *(See Graph 1.)*

Severe fall defoliation may lead to winter kill. Grazing should be adjusted to allow adequate growth and carbohydrate storage prior to freeze up.

Close grazing through fall can result in a thinned, less vigorous forage stand the following year. A perennial plant that has been depleted of energy the previous year will produce less forage during the following growing season.

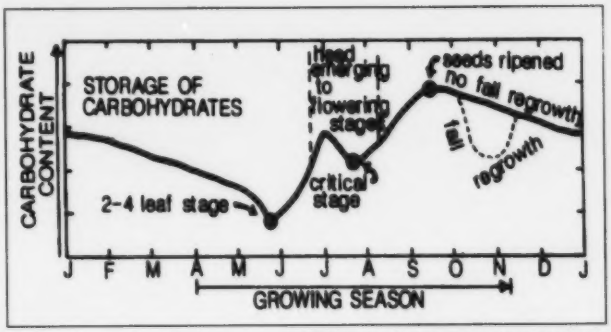
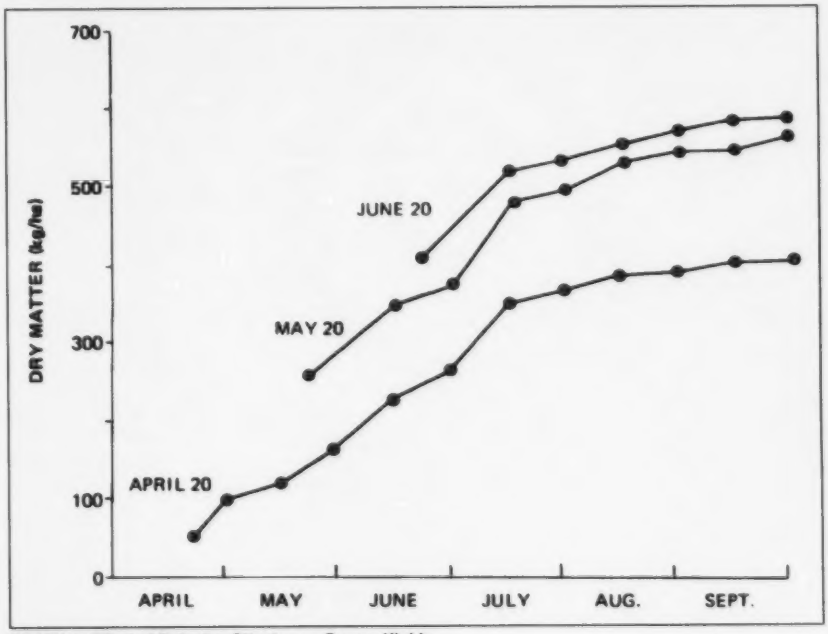


DIAGRAM 14: Carbohydrate Storage Cycle



GRAPH 1: Effect of Delaying Clipping on Forage Yields

Average cumulative yields of mixed prairie when clipping at two-week intervals was started on three dates, April 20, May 20 and June 20.

Severe fall defoliation.

Close grazing of a dormant plant also removes valuable insulating and snow-trapping material. The living plant material is left with little protection against killing winter temperatures.

Managing Carbohydrates

Pastures are generally grazed during periods of active growth to optimize livestock performance. Although grazing reduces carbohydrate reserves, the impact is short-lived if grazing is not severe or continuous.

Carbohydrate removal from storage is not a problem as long as it is replenished. Grazing schemes that provide for non-use or rest intervals, which allow leaf regrowth and carbohydrate buildup, are more desirable than continuous grazing.

Adequate carbohydrate reserves are best maintained by:
1. delaying initial grazing on native range.
2. keeping early grazing periods short.
3. leaving adequate leaf area at the end of each grazing period.
4. allowing adequate time between grazing periods for leaf growth and reserve buildup.
5. allowing for adequate time and leaf area late in the growing season for reserve buildup and insulation.

Morphology

Morphological changes occur in the grass plant throughout its development. These changes are easy to see and coincide with certain physiological changes that are impossible to detect visually. Morphological characteristics can be very useful when making grazing management decisions.

Smooth brome with new tillers developing.

Grass Tiller

Vegetative reproduction of perennial grasses takes place through the production of new shoots or tillers. Each grass tiller has a growing point, which may turn into a seedhead, a stem, leaves, roots, joints or nodes, internodes and dormant buds.

The growing point is where new cells develop. Trees, shrubs and forbs have growing points at the outer tips of their branches.

Grass growing points are found just above the last completed joint or node of each stem. In young grasses and in new perennial grass growth, the joints are crowded together near the soil surface. A leaf extends from each of these joints. There may be 10 to 15 joints in the first inch of stem.

All grass tillers begin growth with a growing point developing from a dormant bud. As long as the tiller is vegetative, it has the potential to produce an indefinite number of leaves. A reproductive tiller can no longer produce new leaves.

Internode Elongation

As the growing season progresses, hormonal changes in the tiller cause the stem to push upward. The distance between the joints increases, that is the internodes elongate.

The tiller first appears to be vegetative since no seedhead is evident. Elongation is often a transitional stage between the vegetative and reproductive stages of plant growth.

In some grasses, tillers remain in the elongated vegetative stage because the seedhead either never develops or aborts at a very young stage. If a tiller becomes reproductive, producing a seedhead, its potential for leaf production is cut off.

Continued Growth

Seedhead production does not mean the grass plant stops growing. Each tiller has dormant (inactive) buds located at the nodes at the base of the tiller (basal buds), on the stem (aerial buds) and at the nodes on the stolons or rhizomes. Each dormant bud can produce a new tiller with a new growing point.

Basal, rhizome and stolon buds are generally the fastest source of regrowth. While active on some grasses such as reed canary grass, aerial buds are the least productive of the new tillers.

Removing an elongated tiller growing point breaks the dormancy of the buds associated with the tiller. Growth of new leaves from an activated growing point can then occur.

Buds which remain dormant must survive the winter and produce next year's tillers. A spring tiller developing from a dormant bud can be compared to an annual plant developing from seed.

Perennial grasses must be allowed to manufacture and store sufficient energy to develop buds that are vigorous enough to survive the winter and begin spring growth. Later in the growing season, crown energy reserves increase and buds for next year's tillers develop. Consequently, severe grazing near the end of the growing season will reduce the production of crown tissue and cause a decline in forage output the following year.

Grazing and Tiller Growth

Early in the growing season all grass growing points are close to or at ground level. Since livestock cannot physically graze any closer than about an inch from the ground, there is no danger of removing the growing point at this time. Although plants are grazed, each grazed tiller continues to produce new leaf material. However, if internode elongation has occurred, the growing point may be removed during grazing. If this happens, new leaf material must come from dormant buds. *(See Diagram 15.)*

Since a bud developing into a new tiller has no leaves, it must depend on energy provided by either remaining leaf material or storage organs. After severe leaf removal the only source of energy for new tillers is stored carbohydrates.

The developing tiller draws down the stored reserves. If sufficient time is allowed for new leaf material to develop and replenish the carbohydrate reserves, no harm is done. When severe grazing is repeated after an insufficient rest period, the plant starts to sacrifice root growth to produce leaves and it is weakened.

If grazing is not severe, and sufficient leaf material is left, new tiller growth receives energy manufactured by the remaining leaf material. There is no depletion of carbohydrate reserves. In fact, removal of an elevated growing point, under proper grazing management and good growing conditions, can stimulate new vegetative growth, maintaining the plant in a healthy vigorous state.

Elongation Timing

The timing of internode elongation is important.

Kentucky bluegrass, June grass, green needlegrass, red top and many other grasses do not raise growing points until just before entering the reproductive phase. Growing points are maintained close to or below ground level for most of the growing season and are not exposed to removal by grazing animals. These grasses are relatively resistant to continuous, close grazing.

Grasses such as smooth brome, crested wheatgrass, western wheatgrass and Canada wildrye elevate growing points early in their development. Smooth brome, reed canarygrass and western wheatgrass may have elevated growing points without seedhead development at certain times of the year. These species are more productive, but are less resistant to grazing.

Proper Defoliation

Proper leaf removal (*defoliation*) can increase total production under suitable growing conditions.

If a grass is allowed to 'head out' and is only grazed once in the growing season, total yield and quality will be lower than if it were grazed less heavily several times during the season. If grazing considers plant requirements, forage can be maintained in an active growth and tillering phase longer than if it matured naturally. However, good growing conditions must exist and production will always decline as the plant nears dormancy.

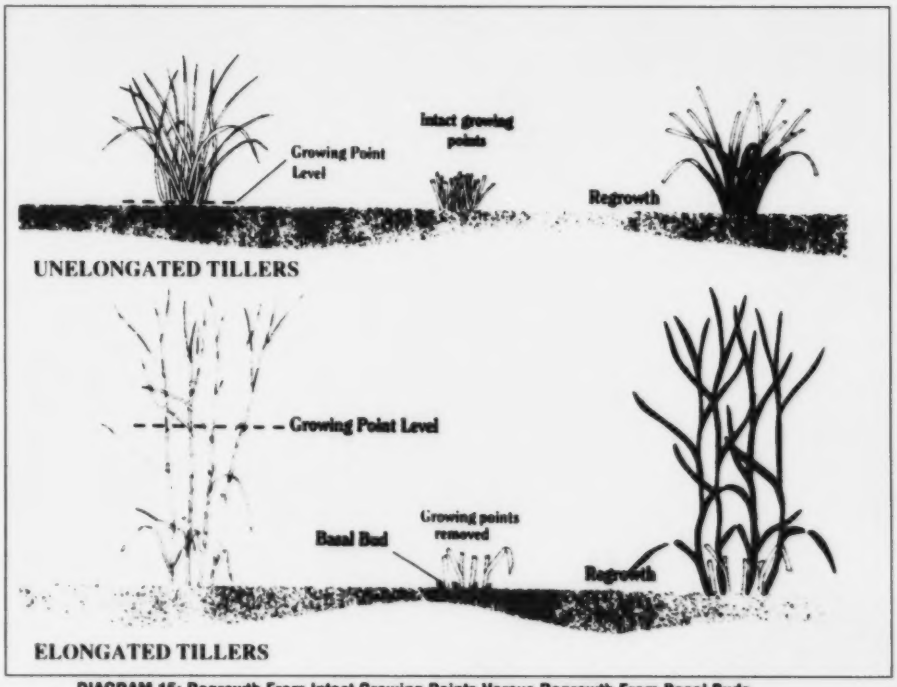


DIAGRAM 15: Regrowth From Intact Growing Points Versus Regrowth From Basal Buds

Studies show that most perennial grass seed production is typically low and often erratic. Thus vegetative reproduction (tillering) plays the major role in perennial grass survival. New tillers receive support from the original plant until their own root systems develop, minimizing adverse environmental affects.

Range management practices should encourage vegetative reproduction with secondary consideration given to seed reproduction.

Root Growth

Roots and underground stems account for more than half of a grass plant's total volume. Roots anchor plants in the soil and absorb water and nutrients. Underground stems, or rhizomes, enable plants to reproduce vegetatively and store carbohydrates.

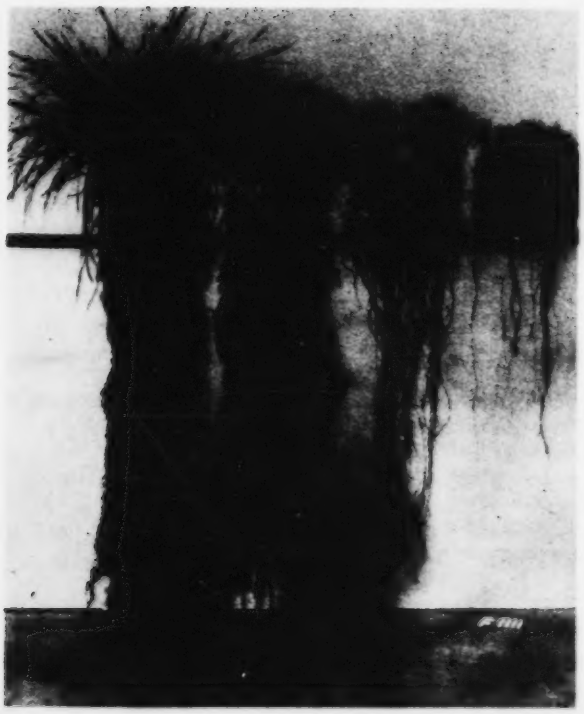
A healthy root system is vital to a healthy plant.

Healthy root systems are vital to healthy plants. Grazing management, therefore, actually involves managing root systems in pastures and rangeland.

Root Replacement

Studies show that grass roots have relatively short lives. Since root replacement occurs rapidly, organic matter is constantly added to the soil.

Canada wildrye roots, for example, live no longer than three years. Only 45 percent of blue grama roots survive over three years.



Rough fescue sod clipped in the greenhouse at various heights every four weeks for five months. Left to right: not clipped; clipped to 12.5, 7.5 and 3.8 cm. Decrease in root volume is evident.

Thus except for large shrub ones, roots are not permanent fixtures and must be replaced regularly. Annual replacement amount varies with species, but ranges from 20 to 50 percent of the total root system.

Leaf Removal and Root Growth

The volume of leaf removal directly affects the root development of all grasses.

Plants respond to defoliation (clipping or grazing) by first stopping root and rhizome elongation. If grazing continues, plants react by reducing root numbers and diameter, branching and soil penetration depth.

The amount of reduction directly relates to defoliation severity and frequency.

One study showed root growth stopping within 24 hours after leaf area removal of 40 percent or more. Another study showed clipping 80 percent of leaf area stopped root growth for 12 days, while removing 90 percent halted growth for 18 days. These roots did not resume growth until the leaves were again actively growing.

Removing 60 percent of leaves resulted in half of the roots ceasing growth. At 50 percent leaf removal, almost all roots continued to grow actively.

The study was conducted under good growing conditions. Unfavorable soil moisture conditions after defoliation may interrupt root growth until the following year.

The degree of defoliation is usually more harmful to root growth than defoliation frequency. Taking a little of the plant more often is a better management strategy than taking all of the plant only once.

Since perennial plants are most common in Saskatchewan, the consequences of overgrazing are carried over from season to season. Continued overgrazing not only reduces the number, size and extent of underground plant parts, it causes changes in species composition that ultimately lead to poor pasture productivity.

GRASSES

Northern Wheatgrass

Agropyron dasystachyum

Life span: perennial
Origin: native
Season: cool
Auricles: clawlike and clasping
Ligule: inconspicuous
Blade: flat, ridged, slightly rough, blue-green

An erect, rhizomatous plant reaching heights of 40-70 cm. Most common wheatgrass of the Prairies. Found in mixed and sparse stands with western wheatgrass or needle-and-thread on clay and loam soils, and occasionally in nearly pure stands on sandy land. A three-way root system makes it resistant to drought and invading weeds. Very dense, shallow root system penetrating depths of about 25 cm takes advantage of surface moisture, while a few deeper feeding roots reach depths of about 50 cm. Distinguished from western wheatgrass by its tufted basal leaves, lighter green color and smooth lemmas. Palatable despite its fairly course stem and harsh leaves. Good forage for all livestock classes. Protein decreases from 16% in early May to about 4% by October. Digestible energy remains high at 45% from emergence to maturity.

Northern wheatgrass.

Western Wheatgrass

Agropyron smithii

Life span: perennial
Origin: native
Season: cool
Auricles: claw-shaped, clasping, sometimes purplish at base
Ligule: inconspicuous
Blade: flat, prominently veined, very rough on upper surface, blue-green

An erect, sod-forming grass with long slender rhizomes. Found in fairly dense stands on clay soils in association with green needle grass, on saline soils with salt-tolerant grasses and greasewood, and in sparse stands among blue grama and needle-and-thread on upland sites. Rigid, blue-green leaves grow at a 45-degree angle from the stem. Well-adapted to surviving drought and taking advantage of light rains. Rarely matures to seed stage, spreading by rhizomes. Fair yielding, palatable, nutritious and digestible. Cures well on stem. Varieties available for seeding.

Western wheatgrass.

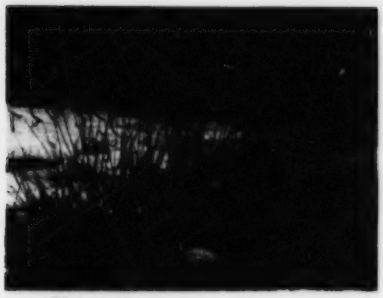
Slough Grass

Beckmannia syzigachne

Life span: annual or biennial
Origin: native
Season: cool
Auricles: absent
Ligule: large, pointed, membranous
Blade: wide, flat, stiff

An erect, tufted grass forming large bunches from fibrous roots. Common in shallow sloughs and marshes. Prefers clay soils covered with a shallow layer of organic matter. Found in Canada's southern areas, and grows throughout the States except for the southeast corner. A stout plant with shallow roots supporting a leafy stem that can reach 1 m in height. Branched head is a closed panicle. Seeds sickle-shaped and hard-coated. Palatable to cattle and horses from early growth until seed is nearly ripe. Nutrients well-balanced, with seasonal protein levels constant but slightly lower than upland grasses. Makes good but light hay.

Slough grass.



Blue grama.

Blue Grama

Bouteloua gracilis

Life Span: perennial
Origin: native
Season: warm
Auricles: absent
Ligule: fringe of hairs
Blade: flat to loosely inrolled, sparsely hairy on upper surface

A short-growing, densely tufted, sod-forming grass. Most abundant in southern regions, it grows from the Saskatoon/North Battleford area to as far as Mexico and South America. Flowerstalks reach 50 cm and usually carry two dark brown, sickle-shaped spikes with all flowers clustered along the upper sides. Starts growth late in the season, about May 5 in southwestern Saskatchewan and nearly two weeks later further north. Highly digestible, producing good forage for all livestock classes. Very limited forage productivity. Drought tolerant and resistant to grazing, it abundantly increases under moderately heavy grazing and lack of rainfall.

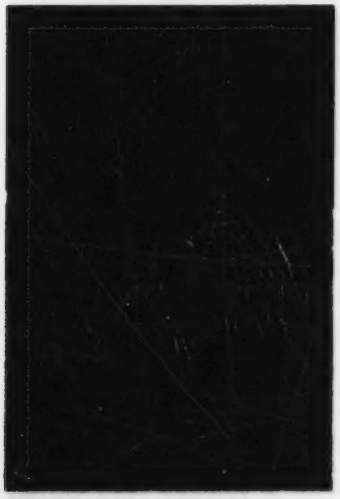
Marsh reed grass (blue joint).

Marsh Reed Grass (Blue Joint)

Calamagrostis canadensis

Life span: perennial
Origin: native
Season: cool
Auricles: absent
Ligule: prominent, pointed, often irregular or split
Blade: wide (6-10 cm), flat, lax, prominent mid-rib

A tall, erect, tufted, rhizomatous grass. Most widespread of the reed grasses, extending southward from the Arctic Circle to the southern States. A moisture-loving plant, growing in marshes, along streams and in moist, shaded draws. Nearly pure stands are occasionally found in shallow northern prairie sloughs. Creeping rootstocks give rise to many coarse stems that may reach 1.5 m. Stems produce rough, lax leaves that may be 30-60 cm long. Develops nodding seedhead with upright branches close to the central column. Seeds are numerous, small and surrounded by a dense ring of hairs growing from the base. Palatability varies. Makes good hay if cut early in July.



Sand grass or prairie sandreed.

Sand Grass or Prairie Sandreed

Calamovilfa longifolia

Life span: perennial
Origin: native
Season: warm
Auricles: absent
Ligule: fringe of hairs
Blade: firm, flat, smooth, wide at base tapering to long fine point

A tall, erect grass with long scaly rhizomes. Grows on sandy prairie and sand dunes, along lakeshores and in open forests. One of the most important species in the Sand Hills, common in association with Indian ricegrass and sand dropseed. Roots extend to 1.5 m, but most found within 50 cm of surface. Surface roots dense, wiry and well-adapted to hold sandy soil. Harsh basal leafage surrounds coarse, leafy stems which may reach 2 m. Palatable during first month of growth and after curing. Leafage eaten during both periods, seeds eaten in autumn. Stems rarely eaten. Despite heavy roots susceptible to trampling and disappears where livestock congregate. Protein drops from 16% in May to about 4% in November, but available carbohydrates increase from 45% in May to 55% in October. Provides good winter pasture.

Timber Oatgrass

Danthonia intermedia

Life span: perennial
Origin: native
Season: cool
Auricles: absent
Ligule: a fringe of hairs
Blade: flat or inrolled, often pubescent on lower surface

A short, tufted grass with fibrous roots. Most common of the five Danthonia species occurring in the Prairies. Found from Quebec to British Columbia and as far south as California and New Mexico. Grows in meadows and upland prairie close to the tree line, and on favorable sites within the spruce and pine zones. Common in the Wood Mountain, Cypress Hills and southernmost Parkland areas. A related species, Parry oatgrass *(Danthonia parryi)*, is found only in the Cypress Hills. Produces an abundance of basal leaves and short, numerous stems. Four to 12 purplish spikelets form a closed panicle which clusters to one side. Flowering occurs in August with seed shatter in early September. Grazed by domestic livestock, deer and elk during spring growth. In overused fescue prairie it may form a solid stand after fescue has been grazed out, indicating livestock prefer other grasses as long as they are available.

Timber oatgrass.

Tufted Hair Grass

Deschampsia caespitosa

Life span: perennial
Origin: native
Season: cool
Auricles: absent
Ligule: very prominent, sharp-pointed
Blade: to 5 mm wide, contracted at collar

An erect, densely tufted bunchgrass with fibrous roots. Widespread and abundant throughout Canada. Grows sparsely in marshes or around shallow sloughs in drier prairie areas. Highly important species in permanently moist sites in the Cypress Hills. Seldom grows under trees. Dense, shallow roots support a mass of deep-green leaves. Folded leaves swell where sheath and blade join. Seedhead a feathery panicle with branches growing in whorls. Two seeds per spikelet. Depends entirely on seeds to reproduce. Good to excellent forage value for all livestock classes, and fair to good for wildlife. Protein content of up to 18% in May decreases to 7% by August. Generally a valuable range grass. Allow seed to set, since plants are short-lived and reproduce only from seed.

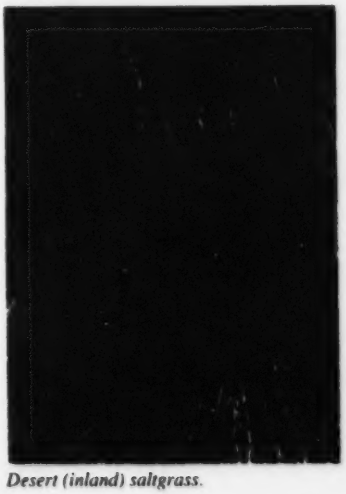
Tufted hair grass.

Desert (Inland) Saltgrass

Distichlis stricta

Life span: perennial
Origin: native
Season: warm
Auricles: absent
Ligule: fringe of hairs, fused at base
Blade: stiff, somewhat awl-shaped, conspicuously 2-ranked

An erect, short, sod-forming grass with extensive scaly rhizomes. Found from the Pacific Coast to the Red and Mississippi rivers, and southward from the northern boreal forest through the United States and Mexico. Habitat includes all moderate saline or alkaline soils, particularly around sloughs and flats. Concentrations of salts are sufficient to reduce growth of all cultivated crops and most native species, even under irrigation. Male and female flower heads are on different plants, but both usually occur in the same clump. Palatability is low, with plants grazed only when better grasses are not available. Well-balanced nutrient composition supports fair to good livestock gains. An important grass for the prevention and control of saline soil erosion.



Desert (inland) saltgrass.

Canada wildrye.

Canada Wildrye

Elymus canadensis

Life span: perennial
Origin: native
Season: cool
Auricles: to 2 mm, claw-like, clasping
Ligule: short, not conspicuous
Blade: very wide (1-2 cm), flat, rough on upper surface

A tall, erect bunchgrass with short rhizomes. Found across North America. Grows in sparse stands on sandy soils, in woods, and along river banks, roadsides and other disturbed ground in the Prairies. Considerable basal leafage and tall stems leaf out from base to spike. Nodding spikes of about 15 cm long display two spikelets at each node, which is characteristic of wildryes. Eaten in spring, but not very palatable. Value decreases sharply when mature. Provides fair quality hay when harvested in boot stage, but livestock do not readily consume it and gains are seldom satisfactory.

Rough fescue.

Rough Fescue

Festuca scabrella

Life span: perennial
Origin: native
Season: cool
Auricles: absent
Ligule: membranous, short fringe
Blade: rough, flat to rolled

An erect, large-tufted, robust bunchgrass often with short rhizomes. Found on deep sandy-loam soils in the dark-brown and black soil zones. Dense, grey-green, rough basal leaves produce a bulk of forage. Individual plants spread from tufts growing at the crown edge. Very palatable, it is readily grazed out, particularly with heavy spring usage. Plants are replaced by Northern porcupine grass, needle-and-thread or weedy species. Spring protein content is low and animals often gain slowly. Cures well with digestible carbohydrates remaining high at all times. Best used as summer and winter range.

Hooker's oatgrass.

Hooker's Oatgrass

Helictotrichon hookeri

Life span: perennial
Origin: native
Season: cool
Auricles: absent
Ligule: conspicuous, pointed
Blade: firm, flat, to 5 mm wide, boat-shaped tip

An erect, densely tufted, smooth-leaved grass with fibrous roots. Found east of the Rockies from Alberta to Manitoba, and southward to New Mexico. Grows only where moisture is plentiful in open grasslands. Occurs in the Cypress Hills and Parkland areas. Seldom occurs in solid stands, rather, single plants are scattered among associated species. Rarely accounts for more than 5% of a stand. Densely bunched with a shallow root system and flat leaves. Seedhead a panicle with erect branches clinging closely to central column. Palatable, providing good but not plentiful forage.

June Grass

Koeleria cristata

Life span: perennial
Origin: native
Season: cool
Auricles: absent
Ligule: 1mm, square and ragged
Blade: flat or inrolled, soft, sometimes pubescent.

Long-lived bunchgrass native to North America, Eurasia and Africa. Found throughout open prairie and parkland regions, but less common in open-bush areas. Occurs as single plants in mixed communities rather than dense stands. Shallow, densely rooted plants, which rely on surface moisture, die back when subsurface moisture disappears. Leaves are short, flat, dark-green and distinctly veined, with a few fine hairs near the stem. Almost leafless flowerstalks usually reach 20-30 cm. Closed-panicle seedhead resembles small wheat or barley spike. Seed abundant but of low fertility. Palatable in spring, less so in summer. Preferred in late fall after curing. Protein content of 20% during early spring decreases rapidly to a low of 4% by November. Although widespread and common, contributes little to total forage production. Increases in fair-condition range, but declines as condition becomes poor.

June grass.

Indian Rice Grass

Oryzopsis hymenoides

Life span: perennial
Origin: native
Season: cool
Auricles: absent
Ligule: conspicuous, long, tapers to point
Blade: slender, inrolled, smooth to touch

A tall, tufted, wiry grass with fibrous roots. Occurs throughout the western half of North America from central Alberta to southern Mexico. Common on sandy soils and abundant in the Great Sand Hills. Old leaf sheaths located at base help protect numerous long, deep-green, folded basal leaves. Feathery panicle white color caused by light-colored chaff. White hairs of each floret surround single, round, awn-tipped, black seed. One of the most palatable native grasses, which has contributed to its disappearance. Cures well, providing nutritious winter grazing.

Indian rice grass.

Kentucky Bluegrass

Poa pratensis

Life span: perennial
Origin: introduced from Europe
Season: cool
Auricle: absent
Ligule: membranous, to 1mm long, truncate, entire
Blade: boat-shaped tip, keeled

Has invaded many grasslands and is also a common lawn species. Grows abundantly in the moister northern and eastern parts of Saskatchewan in native and seeded pastures where it forms dense sods. Leaves are mostly basal, deep blue-green, folded or flat and keeled. Leaf tips are a characteristic boat-shape while the mid vein appears as a double line or railroad track. Seeds are numerous with a mat of cobweb-like hairs at the base. Palatable and nutritious in early spring, protein content drops after heading out. Rhizomatous roots and good seed production make it a good competitor. Under poor pasture management tends to become a major grass stand component due to high tolerance to grazing and trampling. Unless irrigated, not high yielding in Saskatchewan. Pastures become less productive as plants increase in abundance.

Kentucky bluegrass.

Sandberg bluegrass.

Sandberg Bluegrass

Poa sandbergii

Life span: perennial
Origin: native
Season: cool
Ligule: prominent, pointed
Sheath: compressed, pale or purplish at base
Blade: 4 to 12 mm long, flat or folded with boat-shaped tip

A small, erect bunchgrass with shallow fibrous roots. Found throughout the Prairies but rarely very abundant. Leaves are numerous, fine, folded and mostly basal. Seedhead a closed panicle that is straw colored and shiny when mature. One of the first grasses to grow in spring, usually matures by July with leaves withering into white clumps. Drought resistant, may spread during dry years as less tolerant species die. Provides low palatability and production, which livestock avoid after mid-June. Forms 7-8% of total cover, especially on overgrazed ranges.

Little bluestem.

Little Bluestem

Schizachrium scoparium

Life span: perennial
Origin: native
Season: warm
Auricles: absent
Ligule: membranous(1-3mm), truncate, ciliate
Blade: 3-8mm wide, scabrous on upper surface, smooth below

A bunchgrass producing many pith-filled or woody stems that reach up to 60 cm. Found from Rocky Mountains to Atlantic Coast and Gulf of Mexico to southern Yukon. Dense stands common from the interlake area of Manitoba to the Manitoba-Saskatchewan border. Small, sparse stands occur throughout balance of the Prairies on sandy and gravelly soils. Plants fairly common in the Great Sand Hills, throughout the Missouri Coteau, and along the South Saskatchewan and Frenchman rivers and Swift Current Creek. Palatable early growth furnishes good forage for all livestock classes. After seed shatter, plants provide fair to good forage for cattle and horses. Plants often look ungrazed due to cattle pulling tender leaves out from around the bunch edge. A single, branched panicle tops each stem and produces the characteristic hair-covered and awned seed. Leaves develop a distinctive red tinge after frost.

Sand dropseed.

Sand Dropseed

Sporobolus cryptandrus

Life span: perennial
Origin: native
Season: warm
Sheath: conspicuous tufts of long white hairs at throat
Ligule: dense fringe of fine hairs
Blade: to 5 mm wide, fine-pointed, stiff

An erect or reclining, tufted, small bunchgrass with fibrous roots. Wide distribution throughout southern Canada, the United States and northern Mexico. Often the dominant grass on stabilized sand dunes. Sparse stands found in all sandy soil areas. Solid stems reach 1 m. Plants moderately palatable. Starts growth about mid-May, matures seed before the end of July and cures, becoming unpalatable. Sheds seed before maturity. Protein content, which is only 10-11% in early summer, drops to 5% by fall. Provides a higher fibre content than most other prairie grasses. Buried seeds are viable for more than 20 years.

Needle-And-Thread

Stipa comata

Life span: perennial
Origin: native
Season: cool
Auricles: absent
Ligule: to 4mm long, very conspicuous, bifid apex
Blade: narrow, flat or inrolled, slightly rough

An erect, densely tufted bunchgrass that is one of the more important native species. The most common of the speargrasses, it occurs across Western Canada and extends through the United States into Mexico. Seedheads grow from a stem with a broad papery leaf. Panicles are loosely spreading and branched. Round straw-colored seed hull, about 12 mm long, ends in a twisted bent awn 20-25 mm long. Awns may cause mechanical injury. Seeds have a sharp, needlepoint callus at the lower end. Growth starts in late April and proceeds rapidly until mid-June. Flowering begins in early July with seeds maturing by early September. Forage value is good before awns develop and after grains drop. Palatable and drought resistant, the plants forage capacity is reduced, or grazed out, with heavy use.

Needle-and-thread.

Western (Northern) Porcupine Grass

Stipa curtiseta

Life span: perennial
Origin: nativeSeason: cool
Awn: to 10 cm, twice bent
Ligule: to 3 mm, two lobed
Blade: to 5 mm, flat

An erect, short-leaved bunchgrass. Plant not well-named because it resembles needle-and-thread more than the robust harsh porcupine grass. Usually the dominant species on loam soils in the central Prairies. A related species, Porcupine grass (Stipa spartea), is restricted to the Qu'Appelle Valley. Roots extend to depths of 1 m. Flowering stems, about 1 m tall, produce up to 30 sharp-pointed seeds in a feathery panicle. Seeds, 15 mm long with a 10 cm awn, which is twice bent. Fairly palatable except between seed emergence and dropping. Nutritive and curing properties rate lower than needle-and-thread but higher than porcupine grass.

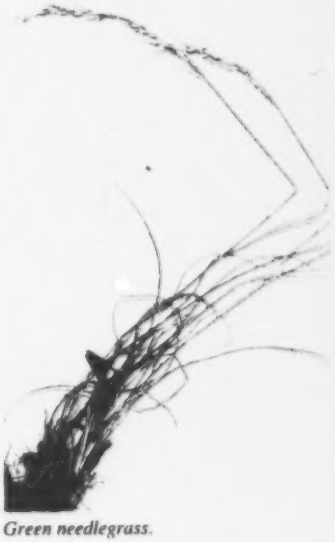
Western (Northern) porcupine grass.

Green Needlegrass

Stipa viridula

Life span: perennial
Origin: native
Season: cool
Auricles: absent
Sheath: hairy at the throat
Blade: up to 5mm wide, flat

An erect bunchgrass with a dense root system that extends to depths of 2-3 m. Found everywhere in the Prairies, it seldom occurs in dense stands. Grows best on heavy clay soils where plants develop in association with western wheatgrass. Good growth takes place on sandy land if roots reach the water table. Leaves are long, green, narrow and mostly basal. Seedstalks can reach 1.25 m. Small, black, hairy seeds are produced in abundance. Lacks the sharp pointed callus of other needlegrasses. Weak awn is seldom over 5 cm long. The most palatable of the needlegrasses, plants are sought by livestock all season long. Spring protein content exceeds 20%, while fall content often tops 8%. Tolerant to drought and cold, plants are moderately resistant to grazing. A cultivar has been developed and marketed as green stipa.



Green needlegrass.

SEDGES AND RUSHES

All Species Listed

Life span: perennial
Origin: native
Season: cool

Awned Sedge

Carex atherodes

Awned sedge.

One of the most important plants growing in fresh to brackish marshes and shallow sloughs across most of North America. Strong rootstalks give rise to numerous three-angled leafy stems. Dense mass of short hairs covers underside of soft three-ranked leaves. Male flower head grows at stem tip; female spike develops among upper leaves. Stands yield up to 4 tonnes of palatable, nutritious hay if protected from grazing and flooded until early July. Provides good forage for cattle and sheep but does not tolerate heavy grazing. Often occurs with non-palatable water sedge (Carex aquatilis) which promotes over-grazing of palatable species.

Low Sedge

Carex eleocharis

Low sedge.

One of the most common dryland plants of the interior plains. Found throughout the Prairies, with heaviest stands occurring on overgrazed or eroded rangelands. Smallest of the dryland sedges. Shallow rootstalk sends up single plants 3 to 10 cm apart. Plants have a central three-angled seed stalk and either 3 or 6 leaves, which extend 2 mm wide and 5-8 cm long. Seed matures in early June, with brown heads and drying leaves distinctive when grasses are green, which should not be confused with grass carry-over. Heavy stands indicate overgrazed pasture. Palatable, but low growth, poor yield and ability to spread with overgrazing make it an undesirable species. Two other dryland sedges are palatable but neither produces much forage. Sun-loving sedge *(Carex pensylvanica)* has wider, glossier and more numerous leaves, and more than one flower cluster on its seed-bearing stem. Blunt sedge *(Carex obtusa)* produces seeds which are nearly black when mature.

Thread-Leaved Sedge

Carex filifolia

Thread-leaved sedge.

One of the most common plants growing in short-grass and mixed-grass regions. While dominant in a few areas, usually found subdominant with blue grama, needle-and-thread and June grasses. Heaviest stands occur on sandy flats and exposed gravelly ridges, or on shallow or infertile soil. Leaves are fine, thread-like, upright, deep-green, rolled and glossy. Chestnut-brown, dead leafage usually surrounds the base of leaves. Male and female flowers are on the same spike. Often more palatable than surrounding grasses, plants may contain higher protein and phosphorus and lower crude fibre. Although trampling may tear plants, they withstand grazing better than associated grasses.

Beaked Sedge

Carex rostrata

An important marsh and slough species in Saskatchewans Parkland and farther north. Dominant when occurring in northern stands with beaked sedge, with the reverse true when paired up in the south. Soft, hair-free leaves grow in whorls of three. Male flowers grow near stem tips; female spikes develop among leaves. Seed ends in a distinctive curved beak. Provides similar yield, protein content and tolerance to haying as awned sedge. Maintains 18% crude protein until mid-summer and is readily grazed by cattle. Produces low-quality hay because cutting rarely occurs at optimum time and it often grows with other poorer grade vegetation.

Beaked sedge.

Baltic Rush

(Juncus balticus)

This most common of prairie rush species grows on a wide variety of sites, but prefers rich soils with high water tables. A well-developed horizontal rootstock combines with extensive and deep fibrous roots. Stems arise at intervals from the rootstock. Leaves are basal and scaly. Brown flower clusters develop below stem tips. Spring crude protein of 16% drops to 9% by late summer. Grazed readily while green and actively growing, but palatability declines with dry plants. Provides suitable hay if cut at the right time.

Baltic rush.

FORBS

Yarrow

Achillea spp.

Life span: perennial
Origin: native
Season: cool

An erect, up to 1 m tall forb growing from extensive rhizomatous rootstalks. Found throughout the Prairies in moist meadows, woods and open grasslands on various soils. Leaves are hairy, deeply divided and lace-like. Small, white-pink, numerous flowers form compact, flat-topped clusters. Forage value is poor, with only flower heads usually grazed. An abundance indicates heavily grazed pasture.

Yarrow.

Everlasting (pussy-toes).

Everlasting (Pussy-Toes)

Antennaria spp.

Life span: perennial
Origin: native
Season: cool

Woolly, mat-forming, often stoloniferous forbs. Found from Alaska to California and east to the Dakotas under various soil and moisture conditions. Over 10 species are common in the Prairies. Leaves are mostly in basal rosettes and usually woolly or hairy. White or rose flowers in compact heads resemble cat paws. Propagates by seed and vegetatively by both rhizomes and stolons. Usually not abundant, but increases to form ground cover on overgrazed ranges. Little forage value, although flowers are sometimes grazed.

Fireweed.

Fireweed

Epilobium angustifolium

Life span: perennial
Origin: native
Season: warm

An erect fairly stout plant with alternate, very short-stalked, entire leaves. Found in North America from Newfoundland to Alaska. In Saskatchewan, very common in woodlands, forest edges and burned-over forest, and occasionally found along roadsides and moist places in the prairie region. Grows from long creeping root stalks to heights of 1.2 m. Flowers are pink to purple and appear in July and August. Forage value varies; good for sheep, fair for cattle, sometimes used by horses, deer and elk. Good source of honey nectar.

Gumweed.

Gumweed

Grindelia squarrosa

Life span: biennial or perennial
Origin: native
Season: warm

A coarse, erect, branched forb from a taproot. Found throughout the entire unwooded Prairies, on dry range, roadsides and saline flats. Leaves are thick, hairless and gummy with toothed margins. A sticky resin covers the numerous, showy yellow flower heads. Unpalatable to livestock or big game. Upland game birds utilize its fruits. Increases in abundance on heavily grazed pastures.

Hairy Golden Aster

Heterotheca villosa

Life span: perennial
Origin: native
Season: warm

A semi-flat, woody-taprooted, many-branched, hardy plant. Common on dry sandy prairie and hillsides; less common in parkland. Leaves are numerous, grey-green, alternate and covered with short stiff hairs. Hairy stems grow 15-60 cm high. Bright yellow flowers are usually solitary on the stem. Deep taproot penetrates to 2.4 m. Reproduces from seed. Form varies greatly. Palatability low for both livestock and wildlife. An abundance indicates range deterioration.

Hairy golden aster.

Purple Vetchling/Peavine

Lathyrus venosus

Life span: perennial
Origin: native
Season: cool

The most common of 4 legume species growing in the Prairies. Found in bushland and forest areas. A climber with four-angled stem extending from woody root. Leaves have 4 to 6 pairs of smooth oval leaflets with tendril at tip. Flowers are purple. Palatable, with as high as 30% crude protein in young leafage. Does not cure well. Frost destroys nutritive quality. Often selected by livestock, it is easily overgrazed and the quality of bush pasture decreases accordingly. Root persists for many years, allowing proper grazing management to bring it back.

Purple vetchling/peavine.

Moss Phlox

Phlox hoodii

Life span: perennial
Origin: native
Season: cool

A low, cushion-like, mat-forming plant with coarse woody roots. Found from Alaska to Colorado. Common on Saskatchewan open prairie; less common in parklands. Leaves are numerous, small and needle-like. White-blue flowers are showy and small. A conspicuous early flowering plant forming large masses of white on plains and hillsides. Less noticeable after flowering, it forms a lot of ground cover, especially on eroded hillsides and shallow soil. Prickly foliage generally avoided by livestock. Matted nature protects soil from erosion. Increases as range deteriorates.

Moss phlox.

Dense club-moss.

Dense Club-Moss

Selaginella densa

Life span: perennial
Origin: native

A compact, low-growing, densely matted forb. Leaves are lance-shaped, tiny and arranged in four ranks to form square, rod-like branches. Found in parkland areas, this inconspicuous plant is also one of the most common and dominant species of the drier and open prairies. Usually occupies medium-textured soils, but is plentiful on drier light and eroded soils. Plants are usually less than 1.5 cm tall, with stems almost rooting their entire length. A shallow (less than 8 cm deep) and extensive root system allows plants to rapidly utilize small amounts of water. Helps stop erosion and build soil through decaying organic matter. Provides no forage value and increases with overgrazing and abuse of pastures.

Golden bean.

Golden Bean

Thermopsis rhombifolia

Life span: perennial
Origin: native
Season: cool

An erect branched forb, usually growing in large patches from rhizomatous root-stalks. Found throughout the grasslands and in sandy parkland areas. Leaves alternate and are numerous with three leaflets. Large stipules develop at junction of stem. Flowers are bright golden yellow. Pod curved in a semi-circle. Blooms early and is conspicuous. Provides little forage value, but indicates heavily used areas. Fruit may cause severe sickness in children.

American vetch.

American Vetch

Vicia americana

Life span: perennial
Origin: native
Season: cool

Two varieties of this legume are common. A low-growing variety occurs in moist grassland; the other is an understorey climber. Four-angled stems are easily broken. Leaves are compound with 6 to 12 pairs of leaflets. One or more tendrils grow at leaflet tips. Blue-purple flowers grow in leaf axiles. Flat seed pods break open easily. Produce nodules on roots containing rhizobia that fix nitrogen. Palatable, containing about 20% protein in summer, but low in crude fibre. Disappears with heavy grazing.

SHRUBS

Silver Sagebrush

Artemisia cana

Life span: perennial
Origin: native
Season: warm

A many-branched shrub with gnarled twisted stems and shred-like bark. Very common on lighter soils, rare in parkland areas. Biggest stands occur in the Great Sand Hills. Deep, penetrating taproot. May form extensive colonies by rhizomes. Silver leaves of up to 40 mm long display hair on both sides and are occasionally toothed at the end. Not classified palatable but often browsed. Leaf protein reaches 20% in summer, dropping to 10% in fall. Increases in abundance under cattle grazing, but decreases with sheep browsing. An important winter browse for pronghorn antelope.

Silver sagebrush.

Pasture Sage

Artemisia frigida

Life span: perennial
Origin: native
Season: warm

A densely hairy, silver-grey half-shrub growing from a partly woody base. Wide range throughout western North America. Leaves divide 2 or 3 times into linear segments. Most aerial growth is annual from perennial crown and root. Yellow flowers bloom from July to early September. Handling releases distinct odor. Forage value high but unpalatable. Heavy stands indicate overgrazing. Numerous viable seeds, rhizome growth, drought tolerance and low palatability promote abundance as associated grasses decline.

Pasture sage.

Nuttall's Atriplex

Atriplex nuttallii

Life span: perennial
Origin: native
Season: warm

Low-growing, grey-green, many-branched half shrub with a woody base. Found in southern Saskatchewan on moderately saline soils in association with western wheatgrass, and on shallow soils with blue grama. Branches may be prostrate, reaching 70 cm long. Leaves are alternate, long-oval, stemless, pale-green and scaly. Male and female flowers are on separate plants. Deep roots enhance drought tolerance, but new stems grow slowly after being grazed or destroyed during dry conditions. Despite an unappetizing appearance, very palatable to all livestock classes. Preferred during autumn and winter, but grazed anytime. Provides over 10% protein in late autumn. Contains low crude fibre and high ash levels. Requires careful management to maintain productivity.

Nuttall's atriplex.

Winterfat.

Winterfat

Ceratoides lanata

Life span: perennial
Origin: native
Season: cool

A low-growing, silver-grey, taprooted half-shrub reaching up to 50 cm. Grows on all well-drained soils, but may occur on shallow eroded sites and alkali soils. Fine star-like white hairs cover plants and redden with aging. Male and female flowers are separate on the same plant. Long, silky, white hairs covering female seedhead make plants conspicuous. Extremely palatable with good nutritive balance, and high protein and phosphorus levels into late fall. Grazed out on many ranges due to the plants palatability and susceptibility to trampling damage. Maintaining plants is possible when associated grass management produces a carryover of 40-50% during average-growth years.

Wolf-willow (silverberry).

Wolf-Willow (Silverberry)

Elaeagnus commutata

Life span: perennial
Origin: native
Season: cool

A small tree, growing 2 to 5 m high with brown scaly twigs. Found throughout parkland areas on lighter soils where moisture is plentiful. Silvery, oblong alternate leaves are scurfy on both sides. Dense clusters of yellow flowers in leaf axils produce silver berries. Flowering produces distinctive fragrant smell. Root nodules fix nitrogen. Valuable plant in well-managed pastures but can spread in overused pastures, creating a grazing barrier.

Broomweed or broom snakeweed.

Broomweed or Broom Snakeweed

Gutierrezia sarothrae

Life span: perennial
Origin: native
Season: warm

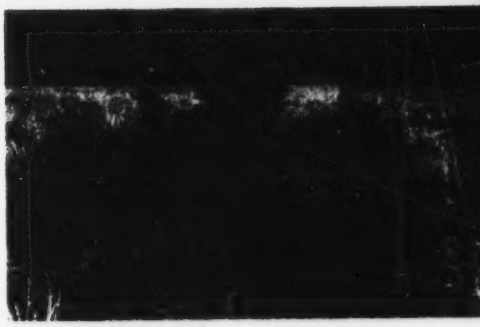
A bushy, many-branched half-shrub growing from a deep woody taproot. Common in dry areas and hillsides throughout prairie and parkland regions. Produces close clusters of numerous yellow heads at its branch ends. Unpalatable and poisonous to sheep and cattle, causing death and abortions. Extremely drought-tolerant with deep roots and narrow leaves. Increases on poor-condition rangeland. An indicator of overgrazing.

Greasewood

Sarcobatus vermiculatus

Life span: perennial
Origin: native
Season: warm

A thorny, free-branching shrub. Found around strongly saline or alkaline sloughs and flats throughout the Prairies. White shredding bark of smooth stems turns grey with maturity. Thorns and branches grow at 90 degrees to stem. Leaves are linear, fleshy and yellow-green. Valuable winter browse for livestock and important wildlife food for porcupines, jack-rabbits and prairie dogs. Poisonous to lambs if eaten in large amounts, especially during spring and summer. Cattle are rarely poisoned. Contains sodium and potassium, with high concentrations of these salts occurring in dry seasons.



Greasewood.

Western Snowberry

Symphoricarpos occidentalis

Life span: perennial
Origin: native
Season: cool

An erect-growing, broad-leaved shrub with a creeping root system. Also known as badger brush, buckbrush and wolfberry. One of the most widespread and common shrubs. Found in dense stands in open prairie, ravines, coulees and woodlands. Traps snow well, but can be a problem range plant. Develops shaggy brown bark and oval-shaped leaves. Pink flowers open in late June, eventually forming white waxy berries by late August. Spreads by creeping roots to colonies of 1 to 200 m in diameter. Overgrazing speeds up root spread, but plants can also expand into dense vigorous grassland. Palatability varies with locality. Plants are usually not grazed.

Western snowberry.

POISONOUS

All Species Listed

Life span: perennial
Origin: native
Season: cool

Milk-Vetch

Astragalus spp.

A forb growing from woody taproots with pinnate leaves of 3 to many lealeaflets. Common in the Prairies on native grasslands and woodlands. Two species are potentially poisonous due to selenium accumulation. Narrow-leaved milk-vetch (A. pectinatus) is found in dry prairie on light and medium-textured soils. Two-grooved milk-vetch (A. bisulcatus) grows on heavier-textured soils in moist habitats. Poisonings are rare, occurring most often in late summeror fall on overgrazed ranges with reduced available palatable forage.

Milk-vetch.

Western water hemlock.

Western Water Hemlock

Cicuta douglasii

The most toxic plant of the north temperate zone. A tall (up to 2 m) erect forb with a hollow stem. Found in marshy sloughs, meadows, wet draws and stream banks in grasslands and forest. Leaves are twice-divided. Leaflets of 5-8 cm long have toothed margins. Flowers are small and white in an umbrella-like head. Hollow chambers divide horizontal cross portions of thick stem base. Short, tuberous rootstalks emit a yellow, aromatic, extremely poisonous oil. Oil is concentrated in roots, but young shoots contain troublesome amounts. A single root can kill a cow. Symptoms include frothing at mouth, uneasiness, pain and then violent convulsions. Treatment is not usually possible. Plants are easily pulled out of the ground by grazing livestock. Avoid confusing plant with non-poisonous cow parsnip (Heracleum lanatum), which has once-divided leaves with large leaflets.

Locoweed.

Locoweed

Oxytropis spp.

A forb growing from a taproot with no apparent stem. Four species are found in the Prairies. Early yellow locoweed (O. sericea) and late yellow locoweed (S. campestris) are common in dry and moist prairie, respectively. Two other species with purple flowers are less common. Pinnately compound leaves produce odd-numbered, silky or short-haired leaflets. Exact nature of toxic substance, locoine, is not known. Low palatability, but grazed if other forage is scarce, especially in spring. While poisonings rarely occur today, extensive grazing induces chronic and addictive illness with prolonged consumption causing death. If numerous, exclude addicted animals from ranges.

Arrow-grass.

Arrow-Grass

Triglochin spp.

A grass-like plant with solid, leafless stems growing from deep rhizomes. Found in salt marshes and alkaline sloughs throughout western Canada. Leaves are basal, spongy and crescent-shaped in cross sections. Hydrocyanic acid (prussic acid) is produced in the plants fresh or dried leaves by the mixing of two usually separate non-poisonous substances. Drought, frost, grazing and trampling cause the poison to develop and injury to occur. Foliage is readily eaten if livestock are hungry or thirsty or need salt. Consumed amounts of as little as 5% of animal's weight may be fatal. Asphyxia or respiratory paralysis cause death. Symptoms usually progress too rapidly for treatment. Avoid infested areas. Herbicides for selective control are not available. Non-selective herbicides are not effective.

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PRINCIPLES AND CONCEPTS

Range management can be defined as the art and science of producing sustained yields of livestock and wildlife while maintaining ecosystem integrity.

The five basic principles of range management, when followed, lead to increased livestock production, improved watersheds and ecosystem stability. They are:

1. graze range at the right time of year and to the right degree.
2. leave adequate leaf area to ensure regrowth.
3. allow each range unit time to be free of grazing animals during the active growth season.
4. control livestock distribution and access to minimize selective grazing behavior and prevent regrazing of plants.

Top: Cattle on native range too early in the season.
Above: Crested wheatgrass is best used for early season grazing.

5. graze the correct animal kind and class on the range and consider its physiological requirements.

Grazing can have long-term negative impacts if these principles are not followed. Poor grazing management initially leads to reduced plant vigor, followed by loss of valuable forage plants, loss of drought resistance and increased bare ground, soil erosion, disruptions in the hydrological and mineral cycle and a long-term decline in range productivity.

Land managers must consider both the forage plant and the grazing animal when making management decisions.

The Forage Plant

Beneficial Grazing Effects

There is a special relationship between plants and grazing animals. Grazing does the following:

1. removes older tissue that is less efficient photosynthetically than young tissue.
2. increases light intensity to lower, younger tissue.
3. increases stomatal resistance promoting water conservation.
4. increases forage production due to compensatory growth.
5. recycles nutrients available in urine and dung.
6. speeds senescent forage breakdown by trampling.

In practice, plant response to grazing is complex and is related closely to genetics, environment, phenological stage, and intensity and degree of grazing. Grazing ceases to be beneficial when the plant is compromised.

Seasonal Carbohydrate Storage

Non-structural carbohydrates (sugars and starches) are used as energy for plant growth and respiration. Carbohydrate reserves are necessary for winter survival, early spring growth and regrowth after defoliation.

Non-structural carbohydrates are stored in stems, crowns, stolons, rhizomes, roots and leaves. Non-structural carbohydrates stored in the roots are primarily used for root growth, while those stored elsewhere support above-ground growth and regrowth.

In order for non-structural carbohydrates to accumulate, photosynthetic production must exceed respiration demands. Defoliation removes photosynthetic tissue, causing the photosynthesis/respiration ratio to change. Stored energy must therefore be used to initiate regrowth. Defoliation which removes only some tillers from a plant, while leaving others, is less detrimental because non-structural carbohydrates may be transferred from ungrazed to grazed tillers.

Carbohydrate levels follow a seasonal pattern with a low occurring at the two to four-leaf stage, and maximum storage happening at seed ripe. Grazing which is too early, too severe or at the wrong phenological stage weakens plants. Successful grazing systems take these factors into account.

Root Growth

Root growth ceases within 24 hours of severe defoliation in many grasses and, in most cases, will not resume for 10 to 14 days. If soil moisture conditions are unfavourable, root growth may not resume until the following year. Cessation of root growth places the grass plant at a competitive disadvantage with ungrazed plants.

Total Rest Doesn't Work

Protection from grazing often does not lead to the benefits one would expect. A British Columbia study estimates that sites in the rough fescue and ponderosa pine zones would take 20 to 40 years to recover from fair to excellent condition under complete protection from grazing. It suggests grazing during the dormant period to improve range condition.

In some cases fire may be required to return rangeland to its grass climax once shrubs have taken hold.

Proper Season and Degree of Use

Perennial grass plants must have sufficient energy reserves in the form of non-structural carbohydrates if they are to survive winter, initiate spring growth, and recover from defoliation. Carbohydrate reserves can be maintained by:

1. deferring spring grazing until after the four-leaf stage.
2. keeping grazing periods short during periods of rapid growth.
3. allowing adequate time for regrowth between grazing events.
4. leaving adequate leaf area to allow photosynthesis to continue.
5. allowing adequate recovery time at the end of the growing season to enable the plant to store winter reserves.

Most grazing schemes attempt to maintain perennial grass production while preventing encroachment of annual grasses, weeds and shrubs. Many of the most desirable grass species are susceptible to prolonged grazing pressure and will decrease under sustained heavy use. Any decline in the amounts of these key indicator species signals that overgrazing is occurring.

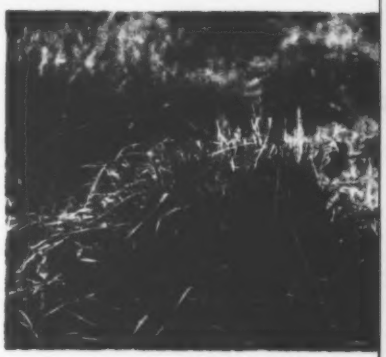
Plants are damaged least by grazing that occurs at maturity or during dormancy. When grazing animals are forced to consume forage of low quality, however, their production declines. Animal performance is best when plant growth is at a maximum. Grazing management therefore involves maintaining an optimum balance between plant and animal requirements.

The Grazing Animal

Distribution

Livestock tend to favor streamside areas and avoid higher elevations, rugged areas and locations greater than one mile from water. Favored areas soon become overgrazed, undesirable plants increase and forage production declines.

Most grazing management schemes aim to provide even distribution and forage utilization over the entire range or pasture while preventing repeated selective grazing of plants. This may be achieved by herding, strategic fence placement, water development and salting.



Leaving adequate leaf area allows for faster plant recovery.

Proper Stocking Rate

Even distribution and forage utilization is a range management goal.

A healthy range or pasture should have a good distribution of all age classes of perennial plants, as well as a mixture of species.

Overstocking and overgrazing leads to a reduction in palatable plant species and an increase in less desirable plants. Overuse also means that livestock must forage for longer periods of time to meet their needs.

Increasing grazing time by two hours per day will lead to significant reductions in cattle gain.

Livestock Physiological Needs

Lactating cows and first-calf heifers have the highest digestible energy (DE) and crude protein (CP) demands. They should be placed on the best quality range.

Yearlings and steers have lower requirements and can be grazed on lower-quality rangeland.

Larger breeds require higher forage qualities based entirely on body size. This is an even more important factor during lactation. Breeds producing more milk and larger calves have elevated energy requirements and may need supplementation or better-quality forage if they are to maintain milk production and be ready for re-breeding.

An overutilized area in a riparian zone.

Proper Animal Kind and Class

Different breeds and species of grazing animals exhibit distinct preferences for both forages and terrain. Continued use by a single herbivore species leads to a decline in preferred forage.

For example, continued use by cattle or elk generally leads to a grass decline and an increase in forbs and browse. Grazing by sheep or pronghorns places more stress on forbs, while use by goats and deer leads to a decline in woody species.

Managers should select the kind of grazing program which best uses forage resources.

CONCEPTS

Plant Response to Grazing

Range plants are classified according to their response to grazing as decreasers, increasers, and invaders. Their responses are complex, and depend on many factors including morphology, locations of growing points, phenology, palatability, weather, type of root system, competition from other plants and grazing history.

The forage eaten by a cow-calf pair over 30 days is an animal unit month.

Decreasers are usually perennials that produce good-quality forage and dominate the climax.

Increasers are species that increase under moderate grazing use, but decrease under prolonged heavy overuse. Increasers are generally shorter subdominant members of the climax community.

Invaders are species that are not members of the climax community. They encroach on a plant community as the range deteriorates.

Proper Use Factors (PUFS)

At one time the range manager's rule of thumb was to "take half and leave half of the current year's forage growth". This is now being questioned as the understanding of how plants grow and defoliation occurs improves.

A Proper Use Factor (PUF) is the percentage of utilization (for a species or range) deemed acceptable to allow improvement or maintenance of range condition. PUFS are useful but difficult to apply because they do not deal with repeated defoliation of individual plants.

Plant species also vary in their resistance to grazing. Certain species can easily sustain themselves with 70 percent utilization, while other species may tolerate only 20 percent removal during the growing season.

Even a low PUF does not eliminate overgrazing. Under range conditions riparian areas often receive 100 percent utilization, while upland areas remain unused. Two groups of plants therefore exist: the overgrazed and the ungrazed.

The Animal Unit Month (AUM)

The AUM is the amount of forage consumed by a 1000-pound (450 kg) cow, with or without calf, in one month. Traditionally a figure of 840 pounds of dry matter per month (28 pounds per day) has been considered the norm. This 840-pound figure allows for losses to trampling, dunging, urinating and insects.

Stocking Rate

Stocking rate is the number of animals on a unit area of land during a month or a grazing season. This is usually expressed in AUMS/acre or AUMS/quarter section. For example, a quarter section of land that grazes 10 cows for four months would have a stocking rate of 0.25 AUMS/acre or 40 AUMS/quarter.

The following table provides animal unit equivalencies according to body weight.

Animal	Weight (lbs)	AUM Equiv.	Forage Dry Matter (daily lbs)	No. per AUM
Cow	1000	1.0	28.0	1.0
Cow	1500	1.4	39.0	0.74
Heifer	700	0.8	23.0	1.25
Bull	1700	1.5	42.0	0.7
Horse	1300	1.2	34.0	0.8
Sheep	120	0.2	5.6	5.0
Antelope	120	0.2	5.6	5.0
Deer	160	0.25	7.0	4.0
Elk	600	0.7	19.5	1.4
Gopher	1	0.006	0.16	177.0
Jack rabbit	7	0.024	0.7	42.0

Stocking Density

Stocking density is the number of animals on a given area of land at any moment in time. For example, an acre of land grazing 50 head of cows for one day each year would have a stocking density of 50 head per acre on that day, but a stocking rate of 1.66 AUMS/acre.

The following table provides conversions from AUMS per acre.

AUM per Acre	Acres per AUM	Acres for 6 Months
0.05	20.0	120
0.10	10.0	60
0.15	6.7	40
0.20	5.0	30
0.25	4.0	24
0.30	3.3	20
0.35	2.9	17
0.40	2.5	15
0.45	2.2	13
0.50	2.0	12
0.75	1.3	8
1.0	1.0	6
1.5	0.7	4
2.0	0.5	3

Carrying Capacity

Carrying capacity measures a range type's ability to produce a sustained forage yield, and thus to meet the requirements of the grazing animal. Carrying capacity is based on a safe utilization level of mean annual forage production, as well as the plant community's grazing pressure tolerance.

Carrying capacity and stocking rate are not necessarily the same.

Carrying capacity does not fluctuate yearly in response to forage production. Stocking rates, however, do fluctuate with weather conditions.

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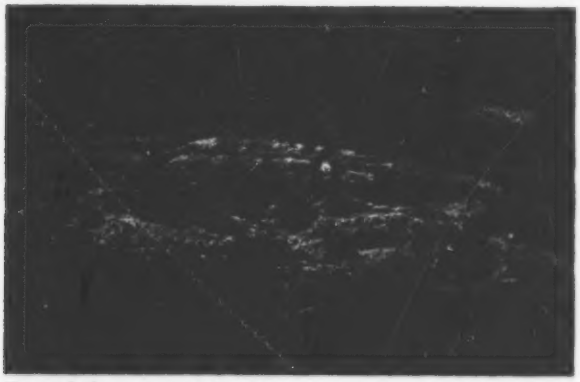
EVALUATION



Top and above: A range site is a product of soil, topography and climate.

Effectively evaluating Saskatchewan rangeland begins with an understanding of the range site concept. Range sites divide rangeland into basic ecological units for study, evaluation and management.

A range site is a distinctive rangeland differing from others by its ability to produce a characteristic plant community. It is the product of all environmental factors responsible for its development. The major factors that interact to produce a distinctive climax plant community are climate, soils and topography.

The climax community is a relatively stable balance of plant species having evolved in the absence of abnormal disturbance. These species are adapted to their surroundings and survive within the environmental limitations of the area. Generally one or two species dominate and this does not vary from year to year.

Mineral recycling in a climax is at a maximum and dominant plant species reproduce themselves forever. Production may fluctuate yearly with climatic differences, but species composition changes very little.

Range sites are distinguished by significant differences in the kinds or proportions of plants making up the climax community, or significant differences in productivity, or both. Significant differences refer to those sites requiring individual management of factors such as stocking rate.

Boundaries between range sites may be distinct where changes in soil, topography, or moisture are abrupt, or less distinct along broader environmental gradients.

A climax plant community.

Identification

Range sites are defined and described by soil texture, profile definition, soil (precipitation) zone and plant species composition.

For example, a range site in the Swift Current area may be an Orthic Brown Chernozemic sandy loam belonging to the *Stipa-Bouteloua-Agropyron* faciation of the mixed prairie association. A range site in the North Battleford area may be an Orthic Black Chernozemic silty loam dominated by *Festuca scabrella* and belonging to the fescue prairie association.

Other examples of descriptive site names are silty, loamy, clayey, subirrigated and saline. Heavy soils can produce more forage and carry more livestock per unit area than coarse-textured soils. Likewise, subirrigated sites have greater potential than dry upland sites. Salinity decreases the plant's ability to obtain water and essential nutrients, therefore reducing biomass production.

Topography is an important influence in determining the climax plant community. Features such as elevation, slope, exposure and landscape position affect run-off and run-on water, evaporation, temperature and other factors that influence what and how much grows.

Two sites may be in the same precipitation zone and have the same soil type, but support extremely different plant communities because they are on opposite sides of a hill.

Northern exposures tend to have lower evaporation rates, lower temperatures and higher soil moisture than southern exposures. The environment on the north side of a hill typically produces more vegetation and has a different plant species composition than the south side.

For a complete description of Saskatchewan range sites, see Abouguendia et al 1990.

Range Site Versus Management Unit

Range sites should not be confused with management units.

A management unit is created by fencing a field or pasture. Management decisions concerning that particular parcel of land can be made regardless of what's happening across the fence.

Several range sites may exist within one management unit. Or depending on fenceline placement, a range site may be divided between two management units - part on one side of the fence, part on the other side.

Just as the range site defines capability or potential, its condition indicates the status or health of the present plant community in relation to that potential, or climax.

Range condition expresses changes in vegetation composition, productivity and land stability. Condition is rated excellent, good, fair and poor, depending on how far the present plant community is from its potential. These ratings are not the same as forage values and do not indicate the nutritive value of species present in a range site.

The relative contribution of each of the three plant categories (decreasers/increasers/invaders) to the composition of the range site determines its present condition and condition rating. *See Diagram 16. See* ***Range Plants*** *for more information about the plant categories.*

Many influences can modify or temporarily destroy vegetation, but they do not necessarily eliminate recovery of the potential plant community. Unless the disturbance is particularly severe or prolonged, the site potential is not permanently affected and the site itself remains capable of supporting the climax community.

In Saskatchewan, for example, range is often considered in poor condition due to drought. This is an inaccurate assessment because range does not decline in condition quickly. Forage production may be temporarily less due to drought, but the range condition is not changed and the plant community composition is likely not altered.

Remember, range condition refers to the health of the rangeland, not annual production.

Deterioration Signs

Plant vigor decline and loss of surface litter are the first warning signs of range deterioration. This is followed by a shift in species composition, the change most easily measured and the main contributing factor to other changes in the site.

Deterioration of the plant community produces loss of organic matter, soil fertility and ability of the soil to absorb and retain water, as well as an exposure of surface stones. This reduces the opportunities for establishing the original plant cover and productive capacity of the site.

Severe deterioration may significantly alter the site potential. A different range site with a much lower potential must then be recognized and managed accordingly. A reduced stocking rate, for example, is one necessary management change.

With tame pastures where the native vegetation has been removed, departure from climax cannot be used to rate condition. However, there are signs that indicate deterioration of tame grass stands.

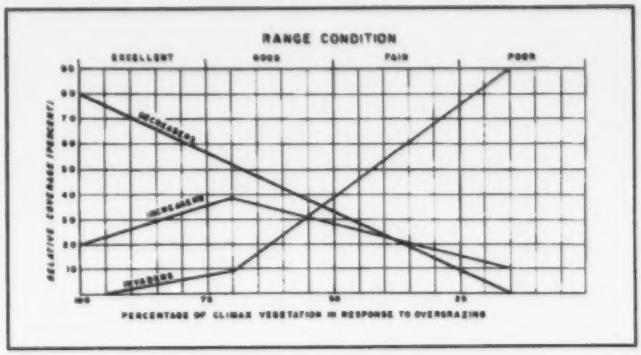


DIAGRAM 16: Relation of Decreasers, Increasers and Invaders on Rangelands

The natural tendency in any plant community is towards succession. Nature attempts to replace tame forages with native species adapted to the site.

Reduced productivity, increased bare ground or the formation of dense sod are the first visual signs of tame stand deterioration. Replacement and encroachment by increaser and invader species soon follow. For example, crested wheatgrass may be replaced by an increaser such as fringed sage or an invader like Russian thistle.

Fenceline contrasts show changes in range condition due to grazing pressure.

Eventually other site characteristics deteriorate. Erosion becomes evident, the soil absorbs and retains less water, and site fertility drops.

Monitoring helps producers determine range condition.

Range site and condition information is useful when drawing up an inventory for range management purposes.

The inventory of available resources is a simple but often overlooked aspect of the planning process. Whether on public or private land, this inventory is the basis for developing and applying management decisions.

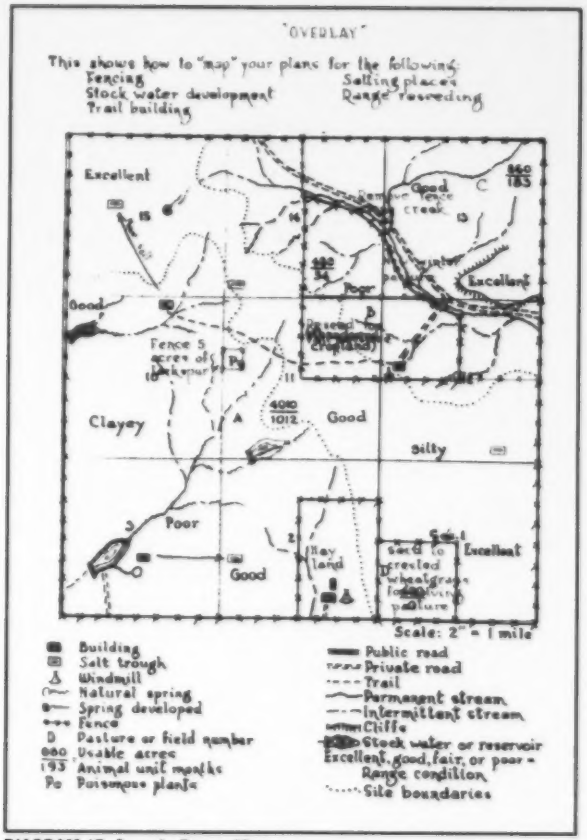


DIAGRAM 17: Sample Range Map

Decisions to maintain, improve or, in rare cases, degrade the present range condition are based on overall objectives. Areas to reseed, rest, prescribe burn or fertilize are mapped out.

Stocking rates, season of use, and kind and class of grazing animals required to achieve objectives are based on the site and condition inventory.

Range trend information is also useful. While range condition reflects the health of the range at any point in time, trend measures change in condition over time. Trend is referred to as improving, declining or stable.

Trend details provide a basis for management adjustment. If condition is not moving in the desired direction, management needs to be altered. Continued evaluations of range trend are used to measure the effectiveness of applied management.

The Inventory

Take stock of the land base and determine its potential as compared to actual production. An inventory of the forage resource base should include:

1. A pasture map showing vegetation boundaries and soil types.
2. Range condition and forage production of native units.
3. Age and production of tame pastures.
4. Topographic features.
5. A record of past use including time of year and stocking rates.
6. Potential problem areas (poisonous plants).
7. Areas requiring special treatment because of wildlife or watershed concerns.
8. Crop aftermath.
9. Hay production.

Tally livestock numbers, classes and forage requirements and compare them to actual amounts produced. This helps determine where shortages are present. In many cases, livestock production is severely restricted by shortages during critical periods, while apparent forage excesses occur at other times.

List physical improvements such as fences, handling facilities, dugouts, wells and equipment. Mark fences, salting areas and water holes on a map or aerial photo. *See Diagram 17 for a sample range map.*

List all equipment, and include age, condition and replacement value details.

List manpower availability and identify training needs.

The following eight tables illustrate how to determine your forage balance.

Record livestock numbers, classes and forage requirements, as well as livestock performance, in the inventory.

Table 1. Stocking rates in AUMS/acre for normal upland soils.

Soils Zone	Range Condition			
	Excellent	Good	Fair	Poor
Brown (dry)	0.25	0.20	0.15	0.10
Brown (moist)	0.35	0.25	0.20	0.15
Dark Brown	0.45	0.35	0.25	0.20
Black	0.55	0.44	0.33	0.24
Grey	0.40	0.30	0.20	0.15

Table 2. Stocking rates in AUMS/acre for cultivated pastures.

Species	Soil Zones			
	Brown	Dark Brown	Black	Grey
Crested wheatgrass	0.5	0.67	1.0	1.0
Russian wildrye	0.5	0.67	0.75	N/A
Brome/alfalfa	N/A	0.75	1.2	1.2

Table 3. Suggested reduction in cattle carrying capacity according to percentage slope.

% Slope	% Reduction in Carrying Capacity
0 - 10	No reduction
11 - 30	30
31 - 60	60
over 60	100 (ungrazable)

Table 4. Suggested reduction in carrying capacity according to distance from water.

Distance from Water (km)	% Reduction in Carrying Capacity
0 - 1.5	None
1.5 - 3	50
> 3	100 (ungrazable)

Table 5. Animal unit equivalencies according to body weight.

Animal	Weight (lbs)	AUM Equivalency	Forage Dry Matter (daily lbs)	No. per AUM
Cow	1000	1.0	22.0	1.0
Cow	1500	1.4	31.0	0.74
Heifer	700	0.8	18.0	1.25
Bull	1700	1.5	33.0	0.7
Horse	1300	1.2	26.0	0.8
Sheep	120	0.2	4.4	5.0
Antelope	120	0.2	4.4	5.0
Deer	160	0.25	5.5	4.0
Elk	600	0.7	15.0	1.4
Gopher	1	0.006	0.12	177.0
Jack rabbit	7	0.034	0.5	42.0

Table 6. Forage inventory.

Forage Class	Acreage	Lbs/ac Avail.	Yield	TDN	Lbs/AUM	AUMS
Native	3200	230	736,000		660	1115
Tame Pasture	340	660	224,000		660	340
Hayland						
Hay	220	4000	880,000	0.50	400	1100
Aftermath	220	250	55,000	0.50	660	83
Cropland						
Grain	90	1440	129,600	0.75	400	243
Aftermath	90	320	28,800		660	44
Total AUMS						2925

Table 7. Stock numbers chart.

Month	Cows	AUMS	Heifers	AUMS	Calves	AUMS	Bulls	AUMS	TOTAL
Jan	180	180			30	14	09	11	205
Feb	180	180			30	14	09	11	205
Mar	180	180			30	14	09	11	205
Apr	180	180	30	25			09	11	216
May	180	180	30	25			09	11	216
June	180	180	30	25			09	11	216
July	180	180	30	25			09	11	216
Aug	180	180	30	25	155	73	09	11	289
Sept	180	180	30	25	155	73	09	11	289
Oct	180	180	30	25	155	73	09	11	289
Nov	180	180			30	14	09	11	205
Dec	180	180			30	14	09	11	205
Totals									2756

Table 8. Feed balance in AUMS.

Month	Grazing	Grain	Hay	Aftermath	Avail.	Req.	Balance
Jan		40	183		223	205	+18
Feb		41	183		224	205	+19
Mar		41	184		225	205	+20
Apr		41	184		225	216	+9
May	219				219	216	+03
June	219				219	216	+03
July	212				212	216	-04
Aug	290				290	289	+01
Sept	290				290	289	+01
Oct	225			64	289	289	0
Nov		40	183	63	286	205	+81
Dec		40	183		223	205	+18
Totals	1455	234	1100	127	2925	2756	+169

The first step in rangeland evaluation is to describe the current plant community. Many methods exist to determine the plant species composition of a range site.

No one method gives a complete picture because each evaluates different features of the plant community. A measure of number, cover or weight is usually taken using quadrat, plotless or line intercept techniques. A discussion of the more common methods follows.

Frequency

Frequency refers to how often a plant appears.

A plant species is rated as present or absent within a quadrat — the number of plants of each species is not counted. Several quadrats are used to gain a good understanding of the plant community. The number of quadrats in which the plant occurs is divided by the total number of quadrats observed to obtain the frequency value.

For example, if western wheatgrass is found in 60 of 100 quadrats, it has a frequency of 60 percent. If June grass is found in only 20 of the 100 quadrats, it has a frequency of 20 percent for that range site.

Frequency measurements allow for rapid collection of objective data since plants are either absent or present. Frequency also tends to give more complete information on a species because a larger area is studied compared to other methods.

However, frequency measures do have some disadvantages, particularly if plants are not evenly spread out. Frequency of each species must be studied separately. A total value for all species has no meaning as it does for cover or production methods.

Cover

Cover measurements are relatively easy to undertake and complete with consistency.

Vegetation cover is a good indicator of the ecological importance of a species. Ground cover gives a good measure of site protection.

Vegetation cover measures the amount of above-ground material relative to ground area. It is usually expressed as a percentage.

Daubenmire Frame

Using a Daubenmire frame (0.1 m^2) is one way to accurately and quickly estimate cover percentage. Constructed of a sturdy material, rebar for example, the frame sides are painted red and white to help mark area percentages.

Canopy cover by species is ranked in each frame as follows:

Rank	Cover %	Midpoint of Class %
1	0 - 5	2.5
2	5 - 25	15.0
3	25 - 50	37.5
4	50 - 75	62.5
5	75 - 95	85.0
6	95 - 100	97.5

Using ranks simplifies the measurement. It is easier to decide if a species falls within a certain class than to estimate exact cover percentage.

When measurements are complete, the ranks are multiplied by the midpoint of the class cover percentage and averaged. The result is an estimate of the amount of space each species occupies, with the total coverage in the plot often exceeding 100 percent. Canopies of different species commonly interlace and plants of different heights often overlap.

This method of estimating canopy cover is accurate enough to use year after year to track any changes in the plant community. However, the information gathered does not show how any changes resulted, or differentiate between an increase in the size of a large plant or the growth of seedlings. To determine this information, a map detailing the size and location of each plant in the study plot is required.

A Daubenmire frame is used to measure cover.

The point frame can be utilized in rangeland monitoring.

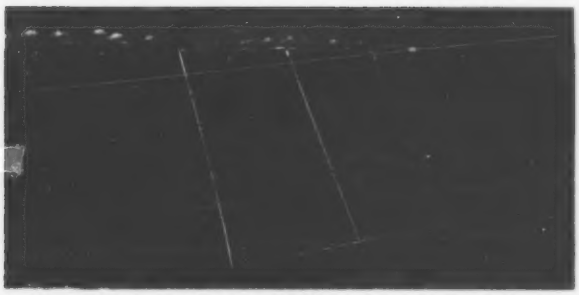
Point Sampling

Point methods of sampling are another way to measure cover. They are based on the quadrat being reduced to a dimensionless point. If enough points are distributed over an area, then the percentage of points directly over a species is an unbiased measure of both actual and relative percentage cover for that species.

Range managers generally use the step-point variation for rapid surveys. A point is marked, or a notch is cut, on the toe of a shoe. The observer then paces a straight line across the sample area, and at regular intervals, records 'hits' under the point. Visual sightings are adequate, or a pin can be used to decrease the amount of bias.

Some important advantages and disadvantages of the point methods are:

1. In sparse vegetation, a very large number of points is required to obtain good individual species estimates.
2. Point methods are best suited to low-growing vegetation. Recording hits on tall species requires the observer to project the point upward. This is difficult to do in an unbiased manner.
3. Recording leaf hits on windy days is difficult.
4. Cover is overestimated if the point size is increased. It must be kept almost dimensionless.
5. In the step-point method, bias may be introduced if observers deliberately or subconsciously lengthen or shorten their pace or deviate from a straight line to avoid obstacles.



Forage production can be determined using cage clippings.

There are various other cover measurement techniques. Most were developed for specific needs and are not widely used.

Production (Weight)

Root development is a measure of plant health.

Plant material weight is an important characteristic of range vegetation. It is a good measure of site productivity and species ecological importance. Carrying capacity is directly related to production.

Production is the total weight of plant material produced over a period of time, while productivity is the rate of production over a specified period of time.

The actual techniques for measuring weight are straightforward, but time-consuming. The most important considerations are what to measure and when to measure it.

Carrying Capacity Indicator

Range managers usually measure weight as an indication of site productivity or carrying capacity.

To measure production in a given year, separate the old material from the current year's growth. Last season's growth may still be attached to perennial grasses and forbs. Measuring this material overestimates current production. On shrubs, measure only the leaves and shoots produced during the current year.

Using production to estimate animal carrying capacities involves understanding the distinction between total plant growth and forage production. Forage is the portion of plant growth that animals can and will eat. It depends on the palatability of the plant or plant part, the acceptable utilization level, and the accessibility of the plant material.

Harvest Method

Clipping and weighing plots is the most straightforward method for measuring production. The standing crop is cut off at ground level or some predetermined level above ground, old growth is separated from the new, and the sample is weighed. Weighing can take place in the field with subsamples measured for moisture correction, or the whole sample can be dried and weighed later.

Dry Weight Basis

Moisture content of plants, particularly the green portions, varies widely depending on the plant part, season of year, current soil moisture and time of day. Thus plant weight is generally reported on a dry weight basis.

Samples should be oven-dried or air-dried before weighing. A subsample can be taken to determine a moisture correction factor.

Limitation

Production is usually measured at the end of the growing season. This is when peak total production should have occurred. There is a net decrease in plant material present after this time.

Although it is the best practical method of estimating total production, there is a serious limitation to this one-time measure. It does not account for losses during active plant growth.

During the growing season materials are transported below ground, respiration losses occur, wood is laid down on old stems, leaves and reproductive structures wither and die, and production is con-

sumed by insects, birds, mammals and fungi. The underestimation of total production may be slight or it may range up to 50 percent of the true value.

If the range has been or is being grazed by livestock or other animals when production is measured, then the areas used for measurement need to be protected. Plant regrowth after grazing is another possible source of error.

Measuring production for one year is not a good indication of the average annual rate of production. Annual production is significantly influenced by rainfall.

Production in good years may be two to five times that of poor years. Serious problems arise if carrying capacities are based only on measurements made during good years.

Taking an accurate range measurement involves a closer examination than is possible from one's horse or vehicle.

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LIVESTOCK BEHAVIOR

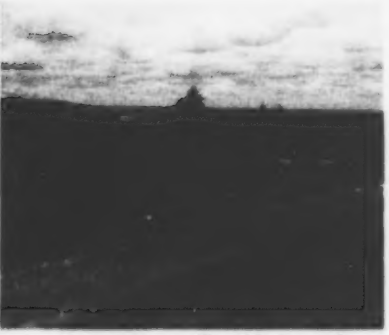
Most problems attributed to livestock grazing can be traced to behavior.

Grazing animals are creatures of habit, using the same areas year after year, often leaving as much as 65 percent of the available pasture untouched. Herds will also establish home ranges and will not deviate from them.

Cattle reluctantly graze steep slopes.

Cattle reluctantly graze on slopes exceeding 15 percent and, in rolling terrain, rarely feed at elevations greater than 70 metres above water. They are also limited by horizontal distance from water, rarely grazing further than 2.5 kilometres from it.

However, greater travel distances cause an increase in energy expenditure.



Range usage is affected by livestock grazing of shaded areas.

Sheep better utilize more rugged terrain than cattle. Sheep show more reluctance to graze areas having natural predator cover, such as bush or topographic relief. They will walk from three to five kilometres for water. Again, travel distance has a significant influence on production.

Cattle require from 40 to 50 litres of water per day on average. This varies greatly, however, and studies show cattle may require up to 150 litres per day in hot weather and dry forage conditions.

Sheep need from 7.5 to 10 litres of water per day. Horses require from 60 to 75 litres per day.

Livestock seek shade during hot summer periods, resulting in uneven usage of forest and streamside areas. Livestock usually overuse dry southern exposures early in spring and then switch to riparian and shaded areas during hotter times of the year.

Range improvements and grazing systems attempt to control livestock behavior. Fencing, salting, herding and water development lead to more uniform livestock distribution. Systems are designed to control timing, intensity and frequency of grazing on individual plants.

The following table summarizes energy expenditures for sheep and cattle experiencing different activities.

Activity	Sheep (45 kg)	Cattle (450 kg)
Standing	4.05 kcal/hr	40.5 kcal/hr
Walking	26.55 kcal/km	265.5 kcal/km
Vertical ascent	29.25 kcal/m	292.5 kcal/m
Walking 10% grade	55.8 kcal/m	558 kcal/m
Grazing	27.9 kcal/hr	279 kcal/hr
Ruminating	10.8 kcal/hr	108 kcal/hr

Good Grazers

Certain breeds are better adapted to grazing rough lands than others. Unfortunately, livestock breeding programs often select animals which do well feeding in a dry lot but not so well on open range. Docile animals which are easy to handle are also selected.

These domestic traits produce poorer rustlers that will not travel far from water holes or graze rugged terrain. This trend can be reversed by selecting animals which show preference for rugged areas while still producing acceptable calves.

Many European cattle breeds came from areas where annual rainfall was over 100 centimetres. Their large body size and superior milking ability was suited to an abundance of easily accessible forage. However, rangeland conditions and rainfall (15 to 36 centimetres) in Saskatchewan do not supply such readily abundant forage.

This suggests that European breeds may not suit our dry rangelands.

FORAGE SELECTION

Grazing animals are selective in what they eat. Diet selection is modified by the presence of secondary compounds (phenolics, volatile oils), plant morphology, such as thorns and thick cuticle, and past experience.

Palatability

Livestock select foods which have the most pleasing texture. They also choose familiar foods.

Green material is preferred over dry material, and leaves over stems. Palatability is affected by fibre content, bitterness or sweetness, water content and plant abundance.

Preference

Forage selection is more a function of past experience than livestock breed.

Grazing is an acquired ability which occurs at an early age. This means that dietary training is possible, as proven with induced grazing of leafy spurge and tall larkspur by sheep in Montana.

Species Differences

There are distinct differences in forage selection among the various herbivore species.

Cattle and elk prefer grass. Sheep and pronghorn find forbs more palatable. Goats and deer prefer shrubs.

Diet compositions change seasonally as different forages become more or less available.

Often by eating a variety of foods, the herbivore maintains a well-balanced diet.

Improving Quality

Range management techniques can be used to reduce selective grazing behavior and provide superior quality forage.

For example, a monoculture such as crested wheatgrass is easy to manage. It is uniform and selectivity is reduced. Applying fertilizer increases the leaf/stem ratio and water content, making crested wheatgrass more palatable and preferable.

Cattle on poor pasture must graze for long periods to meet their nutritional needs.

Goats prefer shrubs over grass and forbs.

GRAZING DURATION

A number of factors affect the foraging time and diet selection of grazing animals.

Cows which are pregnant or lactating require more food energy than animals which are not. They must therefore spend more time grazing to meet their nutritional needs.

Calves must spend more time grazing as their dams' milk supplies cease to meet their requirements.

Preferred food amount and location also affect time spent grazing.

Cattle use their tongues to gather forage before shearing the plants and, as the grass gets shorter, they have to work harder to gather a mouthful.

Cattle experience a peak grazing efficiency when forage is about 15 centimetres high, eating 70 kg of fresh grass per day. If forage is only five centimetres high, daily

Cattle on lush productive pasture experience peak grazing efficiency.

intake can be cut to 14 kg. (The cow takes between 30 and 90 bites per minute, and by moving her head from side to side in an arc, can bite continuously for up to 30 minutes.)

An animal on poor range with short and widely spaced forage plants must take more bites, travel farther and graze longer to meet its daily requirements. In doing so, it uses more energy to acquire food.

Cattle rarely graze for more than nine hours in a 24-hour period. However, in drier regions of the United States cattle will, at times, graze for up to 13 hours per day. Cattle ruminate from five to nine hours per day, depending on the fibre content of the forage they consume.

Rumination evolved as a predator evasion strategy, creating a sense of well-being in cattle. Supplying hay or straw when pastures are lush and green will increase rumination time and pacify livestock.

The speed at which an animal eats also affects grazing time.

Lactating cows have high energy requirements.

Fast eaters spend more time relaxing in shelter from the elements and predators. Animals which have larger mouths select larger bites of food and therefore eat faster. By comparison, species with smaller mouths such as sheep, antelope and deer are more selective in what they eat.

Grazing Periods

Livestock exhibit distinct periods of grazing, ruminating, resting, standing and watering. If one becomes familiar with these patterns, livestock moves can often be planned to minimize disturbance of their daily activities.

Diagram 18 illustrates that grazing, resting and ruminating times vary seasonally in the northern hemisphere.

Livestock also adjust their grazing periods according to day length and weather conditions. Most grazing occurs around dawn and dusk.

Spells of extreme cold or heat may cause animals to alter their periods of activity. They may seek shelter or shade to maintain their body temperatures with the least possible stress.

Cattle may graze through the night during full moon periods. At higher, cooler latitudes grazing may continue all day as daylight hours shorten. On the other hand, livestock in warmer climates may feed at night to avoid midday heat.

Changes from normal grazing behavior alert the producer that something is wrong.

Livestock which crop grass very closely and graze actively during midday probably lack adequate forage in terms of quantity or quality, or both.

Livestock often change their behavior when placed in large herds or onto new range. They disperse and move through a field rapidly as they compete with other animals in the herd. This can lead to better overall utilization of forage, but also to excessive trampling and forage loss during dry conditions.

If livestock are disturbed by dogs, predators or unfamiliar people, normal activity patterns may be disrupted.

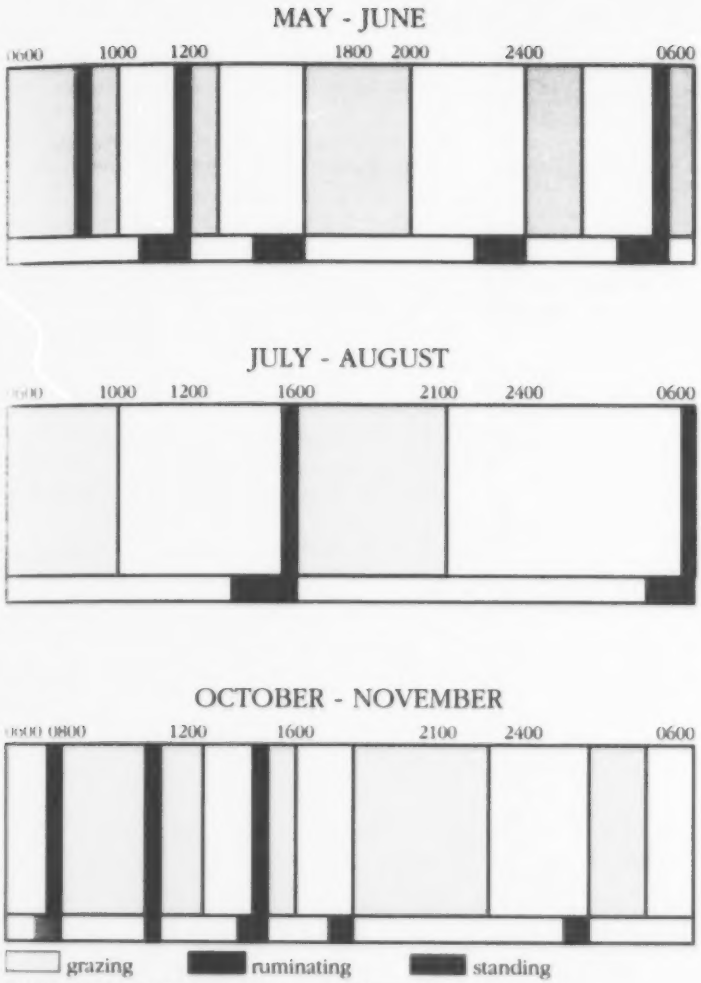


DIAGRAM 18: Grazing Patterns in the Northern Hemisphere

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GRAZING SYSTEMS

Grazing systems manipulate grazing in a planned manner, optimizing livestock production through correct stocking rates and forage use levels.

A well-designed grazing system allows the range to improve while it is being used.

These systems can be applied to grazing by any class of animal in any rangeland or pasture situation. A well-designed grazing system allows the range to improve while it is being used.

Grazing systems control timing, intensity and frequency of grazing on individual plants and improve livestock distribution. An individual animal maximizes gain when animals are allowed to graze selectively at low stocking rates and densities.

Grazing systems should allow for ease of livestock movement.

As stock density and stocking rate increase, individual performance declines, but overall beef production increases to a point. Overall production declines as a pasture becomes overstocked and overgrazed. *(See Diagram 19.)*

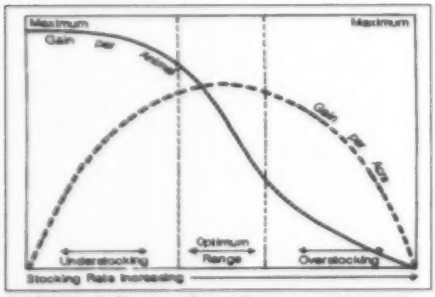


DIAGRAM 19: Stocking Rate Influences on Livestock Production

Over the long-term a successful grazing system does the following:

1. Balances livestock numbers to forage supplies.
2. Distributes livestock uniformly over the range, and reduces selective grazing behavior.
3. Alternates periods of grazing and periods of rest. These rest periods must occur during active growth times to be effective.
4. Maintains a healthy plant community with a desirable distribution of species and age classes. Allows as little damage as possible to grazed plants when they are most susceptible to grazing damage.
5. Maintains healthy watershed and soil.
6. Meets physiological needs of the animals.
7. Optimizes livestock gain per acre.
8. Uses methods which are economically sound, practical to implement, simple to operate and flexible in case of unforeseen circumstances.
9. Takes other equally desirable range uses into account.

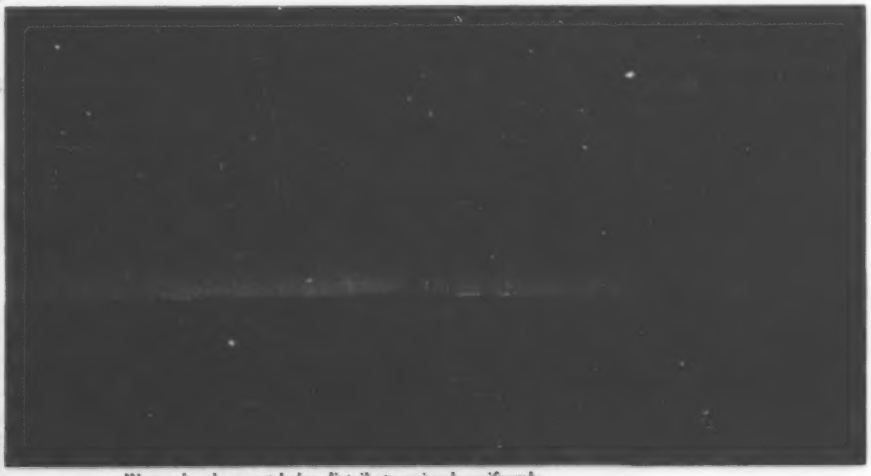
Erecting fences, developing water sites, placing salt and other improvements do not constitute a grazing system. These are tools range managers use to achieve goals. Active management by the producer determines success.

Misconceptions

There are two common misconceptions about grazing systems.

1. A universal best grazing system exists. The fact is each operation must develop its own grazing management system tailored to its resources and goals.
2. Specialized systems permit a manager to ignore other range management principles. The fact is successful grazing systems rely on range management principles such as proper stocking, distribution and proper use.

Brief descriptions of the more common grazing management systems follow.



Water development helps distribute animals uniformly.

CONTINUOUS (SEASONLONG)

Livestock are turned onto grazing allotments at the beginning of the grazing season and remain there until the season ends. This system is popular because it is easy to administer. It requires fewer improvements and less monitoring than other systems.

Stocking rates are generally based on a PUF of 50 percent. Continuous systems do little to control livestock distribution or eliminate localized overgrazing. Many well-documented cases of range deterioration can be attributed to seasonlong use.

DEFERRED

A simple deferred system delays grazing until the key forage species passes through a critical phenological stage, such as seed set.

This reduces the length of the grazing season and allows development of 'wolfy' plants. On the positive side, it provides protection for decreaser species and leads to higher protein levels in the remaining winter forage.

Stocking rates are usually based on a predetermined PUF.

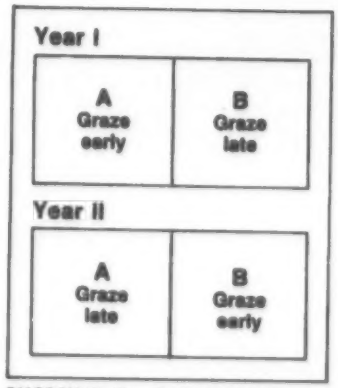


DIAGRAM 20: Two-Paddock Switchback Grazing System

TWO-PADDOCK SWITCHBACK

The range is divided in two by construction of a single cross-fence. This allows the producer to concentrate use on one paddock, while resting the other. Livestock may be grazed on the unit for a predetermined length of time or according to growing conditions.

For example, livestock may graze paddock A for the first half of the grazing season, then A is rested until the following year. Pasture B would be grazed the latter part of the grazing season during year one, as well as the early part of the season during year two. *(See Diagram 20.)*

This is the simplest type of rotational system. Time of use alternates yearly.

A variation of the two-paddock switchback alternates grazing between two fields on a one-third, one-third, one-third basis. The same field is not grazed early in succeeding years.

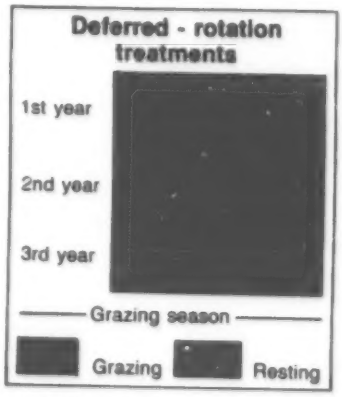


DIAGRAM 21: DRG Grazing System

DEFERRED-ROTATION (DRG)

This system defers grazing on several pasture units in a planned rotation.

In year one a paddock is grazed early until a predetermined PUF is reached. During year two grazing is deferred until seed ripe to allow maximum carbohydrate storage and trampling of seed into the ground. In year three grazing is deferred to allow new seedling establishment. *(See Diagram 21.)*

A minimum of three paddocks is required, making additional fencing and water development necessary. Producers must also spend more time monitoring and moving livestock.

Reducing selective grazing and overgrazing is achieved by concentrating more livestock on a smaller area and forcing better overall utilization. Range condition often improves over time with this system, but livestock may gain less than with other systems.

DIAGRAM 22: RRG Grazing System

REST-ROTATION (RRG)

First developed for Idaho fescue range, rest-rotation grazing has since been adapted for use elsewhere. It is similar to deferred-rotation grazing but has the addition of a yearlong rest period during year three. This yearly rest period ensures establishment of new grass seedlings and allows buildup of carbohydrate reserves. *(See Diagram 22.)*

A minimum of four paddocks is required for RRG, requiring additional development over DRG.

Stocking rates of three AUMS per acre on annuals are common.

RRG has the same advantages and disadvantages as DRG. In cases of severe overgrazing, one year of rest may not be sufficient to allow plant recovery.

The need to allow time for seed production and seedling establishment on perennial ranges has been questioned.

Some experts regard the yearly rest cycle as a waste of forage. Others wonder whether reproduction by seed is important on perennial grass range, since most of these plants reproduce asexually. Seed production is expensive from an energy standpoint.

However, the carbohydrate reserve cycle suggests plants maximize carbohydrate storage if allowed to pass through these stages. Plants which have good reserves remain more competitive in a stand.

COMPLEMENTARY

Complementary grazing systems, which manage seeded pastures and native range to enhance the growth characteristics of each, have been successful in Canada.

For example, crested wheatgrass provides early, highly nutritious forage at a time when native range is most vulnerable to grazing. Crested wheatgrass can be grazed from late April until about mid-June. Livestock are then turned onto native range until mid-September. Russian wildrye can be grazed from mid-September until freeze-up, and finally, Altai wildrye is grazed through early winter.

In Saskatchewan's black and grey wooded soil zones, Regar and other varieties of meadow brome are preferred over crested wheatgrass or Russian wildrye. Meadow brome is easy to establish and competitive, and it provides excellent early spring and fall grazing. It is more versatile than crested wheatgrass because the same pasture may be grazed during both spring and fall.

ANNUALS

In Saskatchewan, annuals such as fall rye, oats and winter wheat provide important grazing. These species are especially important when they complement existing perennial pastures.

Annuals have been used successfully on rejuvenation projects where existing tame forages are broken and the field awaits reseeding to perennial forages.

Annuals provide undesirable plant and erosion control, and interim grazing until sod-forming grasses can be brought under control and a suitable seedbed prepared.

During drought annuals can provide important relief for perennial pastures needing rest. During extreme drought, however, they may fail to germinate or fail to establish.

Fall-seeded fall rye is recommended on brown and dark brown soil zones. It is a good soil stabilizer and is ready to graze early in spring. Maximum production can be achieved by keeping it vegetative through heavy grazing.

Spring-seeded winter wheat is recommended on the dark brown and black soil zones. It will remain vegetative through the growing season, but must be ploughed under in fall. It is usually not ready for grazing until mid-June.

Oats are recommended on black and grey soils because crops seem to respond best under severe drought conditions.

Annuals perform best if divided into at least three units. This allows for better livestock distribution and adequate plant recovery time.

Annuals carry from one to four AUMS per acre over a three-month season. However, input costs are high. Often well- managed perennial pastures perform at equivalent levels without the annual input costs or soil disturbance.

INTENSIVE GRAZING SYSTEMS

'Intensive Grazing' refers to systems which focus on high management inputs and better stock control.

Intensive grazing generally involves the use of eight or more paddocks. *(See Diagram 23.)*

Livestock, at relatively high stock density but not necessarily stocking rate, are rotated through paddocks based on plant growth and recovery time. The goal is to distribute livestock use evenly over the pasture, and reduce occurrences of regrazing of individual plants.

Since intensive grazing allows plants to remain in the vegetative stage for a longer period of time, they can produce an almost unlimited leaf area. Once a grass plant enters the reproductive stage, new growth becomes possible only through new basal buds and tillers. Livestock return to paddocks only after plants have regrown adequately.

Forage production from an intensive grazing system follows a sigmoid curve. *(See Diagram 24.)*

Growth is slow in the initial stages, rapid during the central period and slow again as leaves die. Significant timely rainfall speeds growth or regrowth, altering required recovery time. Grazing intervals and rest periods must be altered according to the growth rate.

Production is maximized if animals can easily and quickly satisfy their appetites with high-quality, abundant forage. Thus determining how much forage to remove from a paddock at any one time is important.

Residual plant material is important for regrowth and efficient harvest by livestock. Cattle grazing on paddocks with poor residual cover must graze longer and expend more energy, and therefore gain less weight.

The time-controlled intensive grazing system involves careful monitoring.

Fertilizing tame pastures can pay off. Fertilizers increase the leaf to stem ratio of grass plants, making plants more palatable. Split application of fertilizers is recommended because nitrogen is often used up within the first three weeks of spring growth.

High-Intensity Low-Frequency Grazing (HILF)

HILF grazing is based on high stock densities that force the animal to use available vegetation. Long grazing periods are followed by long recovery periods. While some plant communities respond well to this practice, animal performance is often poor.

HILF is used most successfully in regions characterized by high rainfall and long growing seasons.

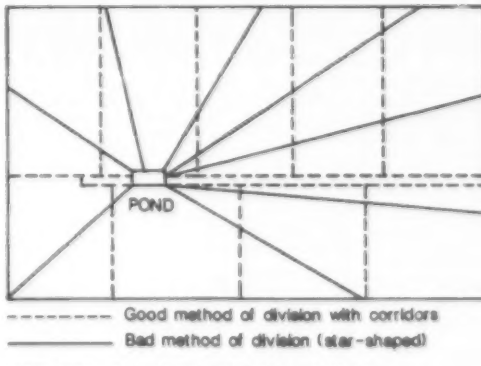


DIAGRAM 23: Intensive Grazing Paddock Divisions

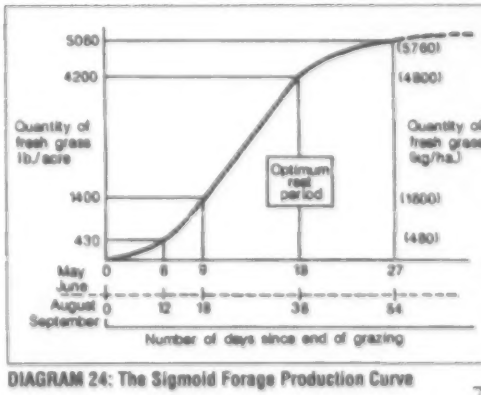


DIAGRAM 24: The Sigmoid Forage Production Curve

Short-Duration Grazing (SDG)

SDG involves relatively high stock densities, but grazing pressures are reduced by shortening grazing periods. These periods are fixed according to the estimated time needed by key forage species to recover from grazing events. For example, using 11 paddocks, moves would occur every six days where plants needed 60 days to recover from grazing.

Time-Controlled Grazing (TCG)

Time-controlled grazing is similar to the short-duration system in stock densities and grazing periods. TCG differs from SDG by recognizing that both grazing times and recovery vary with the growth rate of key forage species.

Grazing periods are brief (one to three days) during rapid growth, but longer (seven to 14 days) during slow growth. Recovery times vary from 14 to 90 days depending on grass growth.

TCG requires the manager to monitor grass growth and moisture conditions more carefully.

Successfully applying TCG involves timing livestock grazing with the active growth of forage plants and understanding the time required by plants for recovery. The number of paddocks in a TCG grazing cell is determined by the amount of time cattle are allowed to graze during active plant growth. The following formula is a useful tool:

$$\text{Paddocks Number} = 1 + \frac{\text{(recovery period in days)}}{\text{(grazing period in days)}}$$

Livestock nutritional requirements and plant physiological needs are both met under a TCG system. This effectively reduces selective grazing, improves livestock distribution and allows for adequate plant recovery time. However, leaving carryover and surface litter to reduce drought effects is still important.

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FENCING

APPLICATIONS

Fencing is an important range management tool, facilitating the practical regulation of grazing use, rest, stocking rates and animal husbandry. Fences control livestock movement and distribution.

Fencing plays a vital role in the range planning process.

Boundary fences prevent livestock from trespassing on neighboring properties. Drift fences keep livestock from moving off or onto a range, or confine herds to specific elevations. Cross-fences are used to subdivide rangeland or pastures into smaller management units, or provide enclosure or exclosure for special uses.

The ideal fence combines a low capital cost and ease of construction with a long lifespan. It is livestock proof.

Although fences simplify livestock containment, they can also lead to less effective management of grazing resources. This is because fences, along with water development, allow the establishment of permanent confines.

Producers can continuous graze a pasture yearlong, even during drought, when under natural conditions grazing animals would either leave the area or die.

The result in many instances is a deterioration of the grazing resource, both native and tame, and production far below potential.

USING FENCES EFFECTIVELY

Temporary fencing.

A properly located fence is a powerful tool when used in a well-planned grazing system.

Always create fields that are as uniform in vegetation type and range site as possible. Livestock will graze selectively if areas of differing slope, soil and forage type are fenced together. This causes overutilization and underutilization in the same field.

Some areas may best be fenced out of the grazing system altogether. For example, weigh the potential for erosion on fragile soils against any economic gains.

Primary fencelines should follow land contours and boundaries of range sites to separate unique management units. Fence hillsides separate from valley bottoms, and bush apart from grasslands. Fence native grasslands separate from tame pastures, and different tame species apart from each other.

All grazing system fences need not be permanent.

Temporary fencing can be used to subdivide fields on a short-term basis. Strip grazing may accomplish certain goals.

Animals can be temporarily confined to achieve brush control. Night confining of livestock is also possible with temporary barriers.

Part of a pasture may be reserved for hay production using temporary fencing.

There is no ideal fencing design.

Available resources and management goals determine field size and shape. Different sized fields accommodate a variation in grazing period. A particular consideration is the use of machinery.

Fencelines do not need to be straight. Although a straight fence is shorter, it is more efficient in the long-term to follow the contours of vegetation types and landforms.

Cattle tend to graze longer in fields that have no shade. However, exposure to long periods of hot weather without shade can adversely affect performance.

Water Sites

Water is often a limiting factor in planning a grazing system and deciding on fence placement. Poor location of water is usually the major obstacle to overcome.

A centrally located water supply is not necessary for a grazing system to work. Separate water sites are not required for each field.

Fences can be used to create alleyways which lead to reliable water supplies. Keep alleys between a quarter and a half-mile long.

Cattle should not have to travel more than a mile on gentle or flat terrain to access water. Shorten this distance in rougher terrain.

Letting cattle drink directly from dugouts, springs and sloughs is a questionable practice. Design fences to exclude livestock from water sites and pump drinking water into troughs.

Keep the area around the troughs as small as possible to prevent animal loitering. Ideally, livestock should come to the troughs to drink and return to graze.

Existing Fences

Although many existing fences can be utilized in a grazing plan, it should not be developed around these fences. They can be moved.

Always consider the best use of the land resources first, and do not let existing fencing limit your thinking in the planning stages.

In Saskatchewan, for example, cross-fences are often constructed on section or quarter section lines. This is convenient but seldom leads to the best use of the grazing resource.

The repair of existing fences is another consideration. If major repairs or replacement are necessary, evaluate the current location and construction. A change in placement and technology may lead to improved or easier management.

Pump livestock drinking water into troughs. Solar pumps are efficient and economical.

CONVENTIONAL WIRE FENCES

Built for durability, the lifespan of a well-constructed barbed wire fence is 25 to 30 years. Choice of materials and design are important considerations for fenceline longevity.

Posts

Wood posts are used extensively due to availability, ease of handling and low cost.

Steel posts are easier to work with but are more costly than wooden posts. Concrete posts can be formed on the ranch or farm, but must be adequately reinforced with steel. They are heavy and difficult to handle.

To minimize maintenance costs, treat wood posts. Untreated wood which contacts the ground decays in three to 12 years.

Pressure-treated wooden posts are usually better than ones treated with a non-pressure process, because the preservative is forced into the wood to a greater depth. Pressure treating can add up to 25 percent to the fence cost but it extends post life by 20 years.

Some preservative treatments can be carried out on your operation. Posts must be well-seasoned for these methods to work. Seasoning normally takes two to four summer months, or a six to eight-month winter period.

To determine the degree of seasoning, weigh a few posts weekly. When a post loses less than 0.45 kg (1 lb) per week during good seasoning weather, it is ready to be treated.

The following table provides various sizes of pressure-treated posts.

Post Use	Length (ft)	Length (m)	Top Diameter (in)	Top Diameter (cm)	Approximate Burial Depth (ft)	Approximate Burial Depth (m)
Corner, end, and draw posts	8	2.4	5-6	13-15	4	1.2
Corner, end, and draw braces	7	2.1	4-5	10-13	3	0.9
Line posts	7	2.1	3-4	8-10	3	0.9
	6	1.8	3-4	8-10	2	0.6
	6	1.8	2-3	5-8	2	0.6

Barbed wire remains the most common type of range fence.

Pentachlorophenol, creosote, naphthenates or bluestone can be used. Paint may not stick to posts treated with pentachlorophenol. Creosote is effective but toxic and bothersome to handle.

Bluestone is extremely corrosive to steel. Treatment vats should be wooden, concrete or lined with polyethylene.

Copper sulfate is poisonous to animals. Do not leave tanks unattended and dispose of unused chemicals in safe containers.

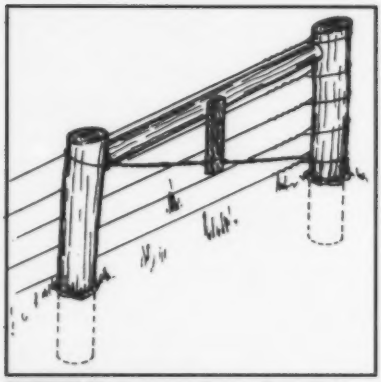


DIAGRAM 25: Horizontal Gate or Fence End Strainer

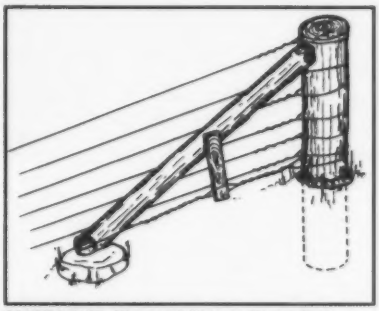


DIAGRAM 26: Diagonal Gate or Fence End Strainer

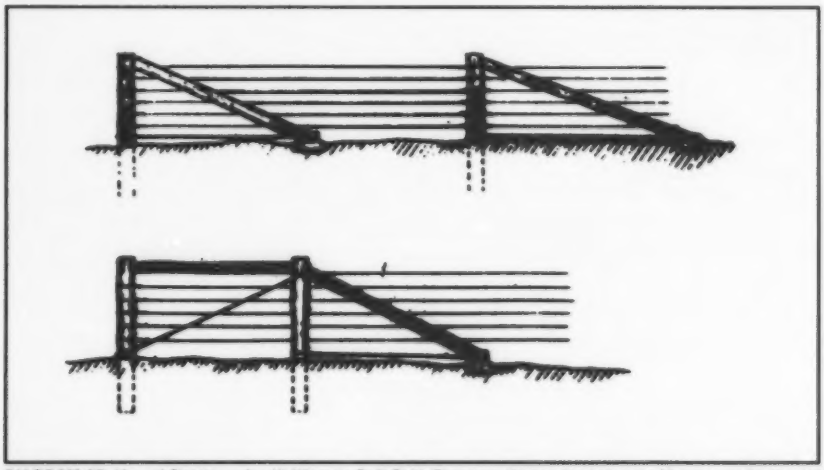


DIAGRAM 27: Use of Strainers for Holding in Soft Soil. Top: two diagonal strainers. Above: one horizontal and one diagonal strainer.

Wire

Barbed wire is available in two types - double strand and single strand. Single strand is lighter and stronger, has more barbs per metre and is less costly. Double strand must be stretched, while single strand needs only to be pulled taut.

Staples

The recommended staple is galvanized, 1 3/4" X 9 gauge with slash-cut points.

Wire Stays

Stays are used to keep wires properly spaced when posts are located at distances greater than 5 to 7 m (16 to 22 ft).

Two types are available. One-piece stays consist of a wire formed into a double spiral 1 m (40 in) long. It is installed by twisting the top wire down over the bottom wire.

Two-piece stays have a single spiral and a straight wire 1 m (40 in) long. They are installed by placing the spiral wire on one side of the barbed wire and inserting the straight wire through the spiral wire, locking the barbed wire into place.

Construction

Brace and corner assemblies are the foundation of a conventional fence.

Braces determine structural soundness and longevity. Corners are braces located where fence direction changes. If any brace or post fails, there is a loss of wire tension and fence effectiveness.

The horizontal brace is widely accepted as the standard fence brace. It is structurally sound and appropriate for most fences. *(See Diagram 25.)*

The diagonal brace is structurally equal to the horizontal one, and is eight percent more resistant to overturn and 25 percent less expensive to buy and install. *(See Diagram 26.)* Be sure the end of the diagonal brace which contacts the ground is free to move forward, and that it is not blocked by a stake or post. The diagonal brace should be as long as possible.

Horizontal and diagonal braces can be used together to hold in soft soil. *(See Diagram 27.)*

Corner and end posts should be 13 to 15 cm (5 to 6 in) in diameter and 2.4 m (8 ft) long. Brace posts should have 10 to 13 cm (4 to 5 in) tops and be 2.4 m (8 ft) long. Horizontal braces should have a 9 cm (3.5 in) minimum end diameter and be 2.4 m (8 ft) long. Diagonal braces should be 3 m (10 ft) long.

Line posts are used to suspend the fence wire. Posts can be 6 to 10 cm (2.5 to 4 in) in diameter and 1.8 to 2.1 m (6 to 7 ft) long. They are usually set 0.6 to 0.8 m (2 to 2.5 ft) into the ground at spacings of 5 to 7 m (16 to 22 ft). Shorter posts are used for low fences and deeper-set posts for soft ground.

Reduce post spacing where the terrain is uneven or a particularly strong fence is needed. Increase post spacing on flat terrain or where livestock crowding is not a factor.

The intended use of the fence determines wire spacings. *(See Diagram 28.)*

To install barbed wire, unroll, stretch and fasten one line at a time starting with the top strand. Unroll the wire on the livestock side of the posts. Tension wires up to 45 kg (100 lb) before stapling line posts.

Never drive staples all the way 'home' on line posts. Leave a space of approximately 3 mm (1/8 in) between the post and wire to allow movement of the wire through the staples. Otherwise, fence impacts are absorbed between the two line posts rather than being distributed evenly between brace assemblies.

If a barb is located within 2.5 cm (1 in) of the staple, clip off the barb.

To prevent pull-out, use the recommended staples and drive them properly. Straddling the wood grain of the post prevents splitting which reduces the staple's holding capacity. *(See Diagrams 29 and 30.)*

Slash-cut points act as wedges to force the staple legs to curve away from the flat surfaces of the point as the staples are driven into the wood. To achieve outward curvature, rotate the staple slightly (20 to 30 degrees off vertical) away from the flat surface of the point on the upper leg.

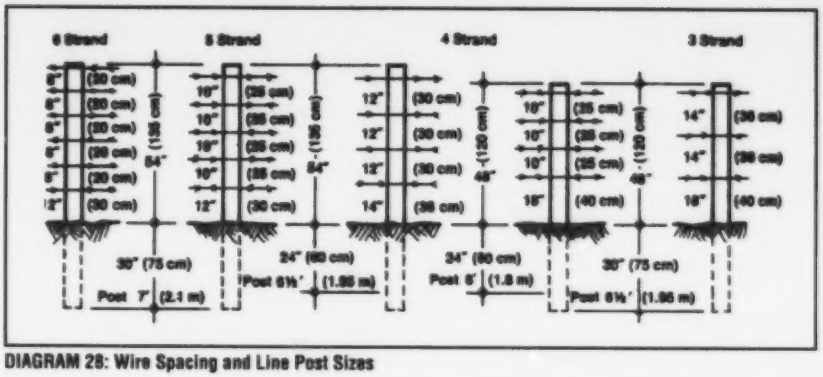


DIAGRAM 28: Wire Spacing and Line Post Sizes

To counteract the forces acting on wires, drive staples at an upward angle into posts in dips or at a downward angle into posts on rises. Do not use the staple to pull the wire to the post. Hold the wire against the post with your body when stapling.

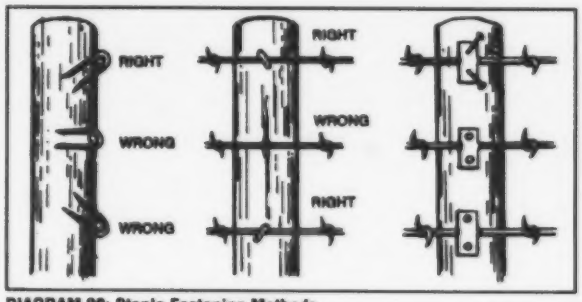


DIAGRAM 29: Staple Fastening Methods

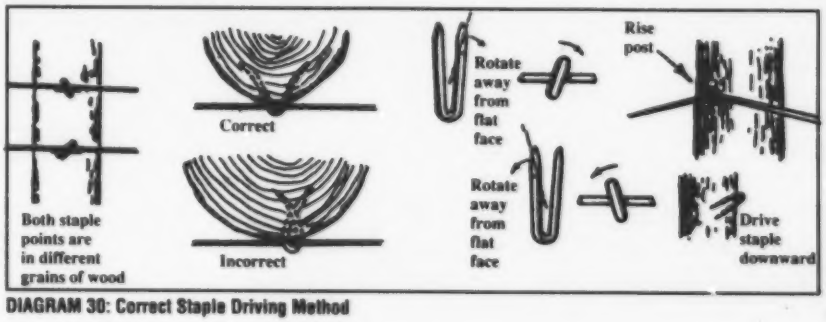


DIAGRAM 30: Correct Staple Driving Method

SUSPENSION FENCES

Suspension fences were originally developed in Texas as interior or cross-fences. They are not suited to hilly or steeply rolling land.

In contrast to the conventional fence which uses the barricade principle to stop livestock, the suspension fence functions as a series of panels with resilience and whip-like action. When pressure is exerted on the top wire, the bottom wire moves in the opposite direction. A cow attempting to reach over the top wire is struck on the leg by the bottom wire.

This type of fence tends to sway in the wind, discouraging livestock from attempting to break through.

Fewer posts are used compared to conventional construction, lowering costs. The quality and setting of corner and brace posts is particularly important with the suspension fence.

Vertical wire spacings are similar to standard barbed wire fences. The fence looses its effectiveness if the bottom wire or the ends of the wire stays drag on the ground or brush. Wires are fastened to line posts with staples or metal clips.

Heavy line posts are spaced from 15 to 50 m (50 to 160 ft) apart depending upon land contour. Wire stays at intervals of 3 to 6 m (10 to 20 ft) are used to maintain wire spacings. Wires should not have more than 7.5 cm (3 in) sag per 30 m (100 ft) span.

Semi-Suspension Fence

This construction is an adaptation of the suspension fence. It is used where terrain is gently rolling.

The semi-suspension fence does not have the live action of a true suspension barricade. It has posts spaced 6 to 14 m (20 to 45 ft) apart.

ELECTRIC FENCES

High-tensile smooth wire fencing has been used in New Zealand and Australia for many years. Now in North America, its popularity is growing rapidly.

Affix signs to a fence warning that it is electrified.

Lower costs, less maintenance, ease of construction and proven effectiveness make electric fencing a viable alternative.

These advantages must not be associated with a job that can be hastily completed. Electric fences require more care in construction with attention to the details of insulating, grounding and ensuring proper electrical connections.

Safety

Use caution when stringing the fence to ensure that wires do not touch any power lines. Wires are conductors even before they are energized.

When an electric fence runs parallel to a high voltage transmission power line, contact the proper authorities for assistance with grounding procedures.

Never attempt to install any portion of an electric fence or do any repairs when the current is on. Disconnect the feed wires or use cut-out switches to isolate the fence segment under repair.

Installation of a lightning arrestor is a good precaution. Often the lightning protection built in to energizers is not sufficient. Unplug the energizer to protect it during lightning storms, disconnecting the ground and fence terminals.

Keep farm equipment and any livestock tethered with chains well away from electric fences.

Workings

An electric fence is a psychological barrier, not a physical one. Respect for the fence is the key to its effectiveness. Once trained, animals do not usually come into contact with the fence again.

Electrical flow in a system requires a completed circuit. The electrical current must travel from its source through the complete system and return to the source.

When electricity flows, the circuit is referred to as 'closed'. When the means are there, but no electricity flows, the circuit is 'open'.

Electric fences remain 'open' until an animal closes the circuit by touching a charged wire, allowing the electricity to flow back to its source.

An electric current prompts two animal reactions. A small current causes a tingling or burning sensation where applied. The sensory nerves are stimulated in the same way the animal feels hot or cold.

A large electric current interferes with muscle control signals and causes an involuntary muscle reaction. The strength of the shock increases with current amount and the time it is available. After involuntary muscle reaction has occurred, increasing the current does not have any more sensual effect, but starts to produce an electrical burn.

Components

An electric fence has four essential components - an energizer to supply and regulate the pulse, wire to carry the pulse, posts to support the wire, and insulators to prevent voltage loss where the wire is anchored to a post.

Energizers

Improvements in energizers have been the most important advancement in electric fencing technology.

With an energizer the useful life of the fence is increased by reducing the amount of abuse it receives. The fence need not be as sturdy as a conventional fence and maintenance is reduced. This translates into a savings in capital and maintenance costs.

Although electric fencers deliver high voltages, they are not dangerous because the pulse emitted has a very short duration. A delay of one second between pulses is sufficient to allow for recovery and retreat from the fence. The energy delivered by each pulse is many times less than that likely to kill or injure animals or people.

Manufacturers usually indicate the length of wire their energizers electrify. A fence should never exceed a continuous distance of 21 kilometres. Energizers are able to produce a powerful pulse because of low internal resistance, but this effect is lost in long fences.

Today's energizer operates somewhat like an electronic ignition in a car. A capacitor capable of storing electrical energy is slowly charged over a period of 1/3 to 1/2 second. A separate timing circuit discharges or releases the energy from the capacitor through a transformer. The transformer steps up the voltage.

The ability of an electric current to produce an electric shock depends on the size of the current and the surface area it is applied to.

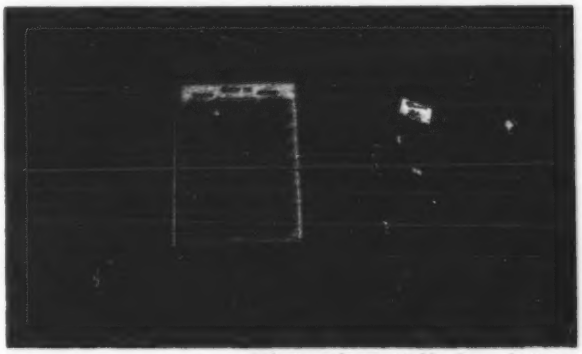
A current applied at a single point may result in an involuntary muscle reaction causing the animal to retreat. The same current applied to a large area only causes a tingling sensation.

Fence guard voltage, the voltage available to force current to flow through an animal when it contacts the fence, must be large enough to cause an involuntary muscle reaction to occur.

The thickness of the animal's fur or hair may prevent it from experiencing a shock. Thus it is important to maintain a high guard voltage on the fence, especially during winter when coats are thicker.

Sheep are particularly difficult to control with electric fencing. They are only affected by a shock to their face area, where insulating wool thickness is minimal. If the fence wires are far enough apart, a sheep can get its head through without touching the wires and climb through the fence without getting a shock. Fortunately, sheep tend to graze up to the fence and contact the bottom wire with their face.

Accepted minimum values for fence guard voltage are 5000 volts for wildlife control, 3000 volts for sheep, 2000 volts for cattle and 700 volts for pigs.



Solar panels can trickle charge batteries which power energizers.

When mainline power is available, 110 or 220 volt plug-in energizers are most practical. They are often more expensive than battery-operated models, but require no battery maintenance and can electrify greater distances of wire.

Battery-operated energizers are useful where line power is not available or practical. They are portable and can be used to charge remote lengths of fence. Many have high output (5000 volts) and can energize fences with several kilometres of wire. The most popular battery-powered energizers use a 12-volt rechargeable wet cell battery.

Never operate a battery energizer from a power adaptor or battery charger, even if line power is available. A battery charger is not designed to withstand the high voltages that are linked across it when the ground connection to the ground rod is loose. The transformer in the battery charger often breaks down and may allow hazardous line voltages onto the fence.

Solar panels are used to trickle charge a 12-volt battery. The photovoltaic cells in the solar panels act to convert the sun's rays to electric energy. The battery must have enough reserve capacity to operate the fence at night and during prolonged rainy periods.

Wire

Several types and sizes of wire and electric string are available.

High-tensile smooth wire has several advantages over barbed wire: lower cost; does not require prestretching to prevent wire sag; responds elastically along the complete length of wire without barbs snagging in posts or staples; is safer and easier to handle. As well, 12.5-guage high-tensile smooth wire is approximately 50 percent stronger than two-strand 12.5-gauge barbed wire.

High-tensile 12.5-gauge galvanized wire is a strong wire designed to last many years. 13-gauge wire is easier to handle and somewhat less expensive, but is more suited to temporary fences or cross-fences.

Barbed wire is not recommended, especially if it is old and rusty. It can also pose a safety hazard. Both animals and people can become caught on the barbs and suffer serious injury if the fence is electrified.

Insulators are essential on wood posts.

Reclaimed telephone wire can be used. It is inexpensive but may require some untangling. However, animals do not always receive a shock from telephone wire because it is galvanized.

A zinc coating protects the steel wire from oxidizing (rusting). Although zinc itself rusts, the zinc oxide which is formed, creates a tight barrier, preventing air and water penetration. Unfortunately, zinc oxide is also a very good insulator. A thin coating on the wire effectively prevents animals from receiving a shock.

Wire spacing and wire number vary with the purpose of the fence. The animal should receive a shock to its face or ears when challenging the fence and not be able to get more than its head through the opening.

If the animal is well-grounded, a single electrified wire is often adequate for cross fences. Alternating ground wires with live wires is important where precipitation is low or rainfall distribution is poor. The ground wire completes the electrical circuit when soil conditions otherwise form poor ground return.

Perimeter fences should have at least three wires. The top and bottom wires must be electrified and the middle wire grounded.

Posts

Proper corner posts are the most important part of fence construction. They should be of heavier diameter 15 to 20 cm (6 to 8 in.) than line posts 5 to 7.5 cm (2 to 3 in). Lighter line posts are used to hold up the wire at proper spacings.

Pressure-treated wood is the most popular type of material for posts and braces.

Fibreglass and plastic posts are convenient and easy to use for cross-fences. They are also self-insulating. Good fibreglass posts have a 10 to 20-year lifespan. Plastic posts may deteriorate in sunlight and become brittle at lower temperatures.

Since electric fences do not need to be sturdy physical barriers, post spacing is further apart than with other fences.

On flat pastures, small wooden posts can be spaced at 45.5 m (150-ft) intervals, with two fibreglass posts in between to maintain wire spacings. Another option is using fibreglass posts at 27 m (90 ft) intervals to support one electrified wire in cross-fences. Perimeter fences must have closer post spacings.

Posts need not be at fixed distances. Adjust spacings to fit terrain contours. Fibreglass posts are not suited to rolling terrain. They will pull out of the ground with any amount of tension on the fence.

Insulators

Insulators are used to anchor the wire to the post and insulate the wire from the post. Plastic and fibreglass posts do not require insulators. It is essential to use insulators on all other types of posts.

Excessive current leakage is the most common cause of electric fence failure. Although some manufacturers advertise energizers that do not require insulators, many other suppliers strongly recommend their use, including with fencer models much stronger than those made in North America.

There are two major types available - porcelain and plastic.

Porcelain insulators are easily broken if hit or the wire is overtightened. They generally must be threaded onto the wire, making replacement of a broken insulator inconvenient. They may also be expensive.

Good-quality, high-density types of plastic insulators are available. Designed to withstand sunlight and temperature extremes, they have lifespans of over 10 years. Some plastic insulators become brittle under sunlight and lose their insulating qualities.

Wire Connectors

To make a good connection, use either crimping sleeves, solderless connectors, screw-type line clamps or flexible connectors. *(See Diagram 31.)* Never twist wires together in the middle or at the end of the fenceline.

The next best splice is a square knot which provides four contact points. Do not use standard loop knots since they provide only one contact point between the two lengths of wire. *(See Diagram 32.)*

Grounding

An electric fence will not work without a proper ground. At minimum, one 3 m (10 ft) long rod is needed for good grounding of a permanent or temporary fence. One 2.7 m (9 ft) long rod is better than three 1.8 m (6 ft) long rods.

Place ground rods where the wire cannot be damaged by livestock or machinery. A permanently damp location or low spot is best. This can be located up to 0.8 km from the energizer.

Make sure connections are tight and protect them from corrosion. They should be checked each season.

When more than one ground rod is necessary, place them at a minimum of 1.8 m (6 ft) apart with a continuous length of wire connecting them.

Gates

Drive-thru or drive-over gates are convenient to use. Permanent electric gates with two or more wires and temporary electric gates with a spring-loaded gate handle reduce costs.

Several spring-loaded wire gate handles, connectors, cut-out switches and fence lift mechanisms are available.

Gates should always be electrified from the latch end, so that when the gate is open and lying on the ground the fence will not short out.

However, gates do not need to be electrified. If animals are trained to the fence, they will not usually challenge a gate. Sometimes animals will not pass through an electrified gate even when the power is switched off. For the operator, an unelectrified gate is more convenient to open and close.

Many producers use conventional gates made of barbed wire or galvanized steel and do not electrify them. In these cases, the charge on the fence is carried underground beneath the gateway or overhead. Underground wires need to be protected by running them through plastic pipe buried at least 50 cm (20 in) in the ground. The end of the plastic pipe is brought up alongside the gate post, then bent down to keep water out, preventing corrosion.

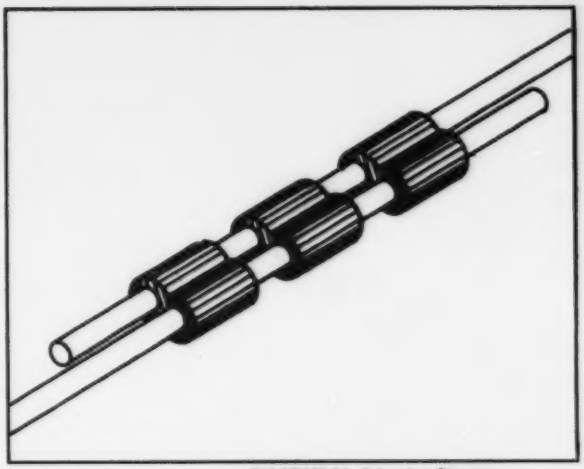


DIAGRAM 31: Crimping Sleeves

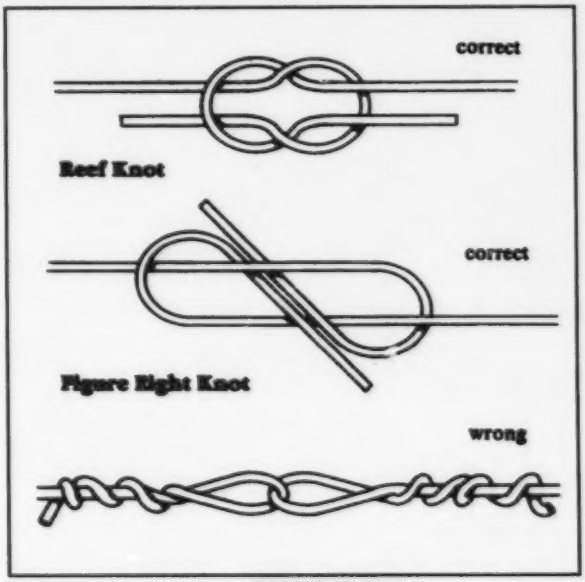
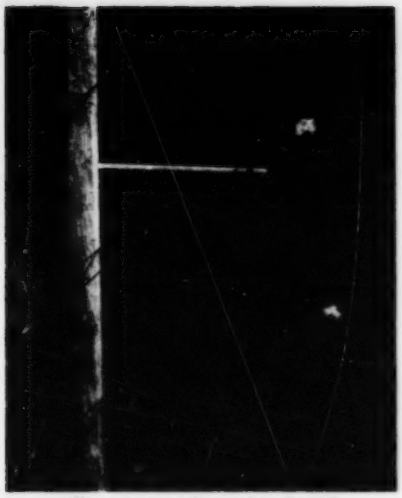


DIAGRAM 32: Knots

Spring-type gates are among the various available designs.



Offset wires can be used to electrify existing fences.

Electrifying Existing Fences

Existing fences can be made sound again with electric fencing. An offset bracket will hold a high-tensile smooth wire about 22.5 cm (9 in) away from the fence. This prevents shorting out and ensures that animals will touch the electrified wire first.

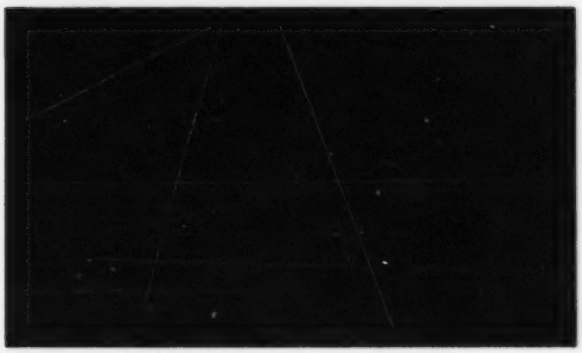
Position the offset bracket about two-thirds of the height of the animals to be controlled. In drought conditions, ground one or more wires on the existing fence to ensure a circuit.

Maintenance

Electric fences require regular attention for proper operation. Inspect and repair all components yearly.

Check fence voltage regularly at several points along the fenceline. A meter or neon tester is a wise investment. Voltage leaks caused by grounding, weed growth and fallen debris are easily detected.

Adjust wire tension due to seasonal temperature changes. Loosen all wires during winter to prevent damage from heavy snow load or extreme temperatures.



Fence voltage should be checked on every pasture visit.

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IMPROVEMENTS

MANAGING UNDESIRABLE PLANTS

A growing problem on Saskatchewan pasture and rangeland is the invasion and spread of undesirable plants. These plants contribute to unhealthy ranges and animals, and can interfere with planned land use.

Undesirable plants include native and introduced grasses, trees, shrubs and forbs. Some are poisonous. All compete with desirable species for water, nutrients and sunlight, resulting in decreased production of desired forage plants.

Although the term weed is often used to refer to undesirable rangeland and pasture species, a weed is a plant growing out of place. This is not always the case with plants referred to as 'range weeds'. Many are part of the natural ecosystem, but their presence or abundance is not compatible with the intended land use.

Saskatchewan's most common native woody undesirables. Top: trembling aspen. Above: western snowberry.

True range weeds invade rangeland or pasture and are not part of the natural plant complex. Many of these species are noxious and their control is legislated.

Learn the names and characteristics of undesirable plants in your area and watch for new growth. It is less costly and easier to manage small infestations than large ones.

Make sure you evaluate the nature and background of the undesirable plant problem before undertaking any treatment measures. The approach and results of these measures are greatly affected by the involved plant, past land use and intended land use.

Collect unknown plants and have them identified. Rural Service Centres, Agriculture Canada Stations and universities can provide assistance with plant identification.

Native Undesirables

Since the advent of the ranching and agriculture era, foraging habits combined with fire suppression have favored the development of increasing numbers of woody plants.

Two of the most widely distributed native woody undesirables in Saskatchewan are western snowberry and trembling aspen. Western snowberry acts as an increaser on many productive range sites. Trembling aspen is the climax species of the aspen parkland, and eventually forms forests in the absence of fire or other disturbances.

In limited amounts neither plant poses a serious problem because each provides food and cover for wildlife and aids in snow catch. Treatments may be necessary when pastures and rangeland become dominated by these species.

Pasture sage, a native half shrub found throughout Saskatchewan grasslands and parkland, occurs even when rangeland is in excellent condition. It is not a problem until it begins to dominate a range.

Improper grazing management and drought promote the increase of pasture sage. An unpalatable plant, it always has a competitive growth advantage over grazed species. If management does not address this problem, pasture sage begins to dominate as desirable forage species are grazed out.

Plant growth is further reduced by drought conditions, especially on sandy and gravelly soils and on south-facing slopes with hotter than normal temperatures. Desirable species are soon overutilized if livestock numbers are not adjusted, giving an even greater advantage to the ungrazed pasture sage. It responds with a rapid increase of plant numbers.

Ground left bare by dying grass plants is soon occupied by pasture sage which is a prolific seed producer.

Foxtail barley is a native grass that increases on saline clay soils during wet years due to a combination of poor drainage, above normal moisture and cool temperatures. Poor grazing management promotes its spread.

Grazing of foxtail barley stops once its stiff awns are produced. The forbs and grasses growing nearby are then consumed, giving a competitive advantage to foxtail barley.

Eventually measures are required to reduce the amount of sage and foxtail barley. However, addressing the original problem of improper grazing management must proceed any control measures.

Foxtail barley increases when less attention is paid to grazing management.

Introduced Undesirables

Undesirable plants introduced into Saskatchewan from foreign countries are well-adapted to our conditions and have spread throughout the province.

Canada thistle, Russian knapweed, leafy spurge and toadflax are persistent perennials and difficult to manage. Their competitive nature allows the plants to dominate permanent pasture and rangeland, excluding desirable grasses and forbs.

Although large tracts of land are frequently occupied, these perennials are usually found in localized patches.

Early treatment may prevent their spread. Keep a record of when and how all measures are taken. Visit the site every year to evaluate the treatment and retreat affected areas when necessary.

Treatment Measure Definitions

Eradication is the complete kill or removal of undesirable plants, including the elimination of sexual or vegetative reproductive structures. It is difficult and nearly impossible to achieve on a large scale. Small-scale infestations can be eliminated, provided areas are visited yearly and re-invasions are treated when necessary.

Control is manipulation and management designed to achieve a reduction in numbers of undesirable plants. The degree of reduction can vary from slight to nearly complete, and involves keeping undesirable plant numbers at a level that minimizes forage loss.

Control is the most common treatment and is often the only practical management of widespread and well-established native and introduced undesirables.

Prevention refers to avoiding an infestation by keeping an undesirable plant out of an area. Purchasing only clean forage seed and hay, ensuring that tarps are used on trucks, cleaning haying equipment when leaving fields, avoiding driving vehicles across infestations, and watching for 'hitch hikers' on clothing and livestock are prevention methods.

Also beware of prevailing winds and water streams which transport seeds. A small percentage of foxtail barley seed remains in the inflorescence in winter, is shed and moves by wind on snow. Leafy spurge and scentless chamomile seeds travel in water.

When prevention is neglected, control and eradication costs are high.

Control Methods

Undesirable plant control on permanent pasture and rangeland requires good vegetation management. Success is based on two principles: competition and succession.

The competitive ability of the undesirable plant must be reduced, with succession proceeding in a desired direction. These goals are achieved by choosing the most appropriate control method for each situation.

Manual Control

Manual control involves pulling, digging and cutting individual plants. These techniques are highly selective but slow, limited to small areas and costly.

Toadflax requires early treatment to minimize its spread.

Manual control is most useful for removing invading plants and cleaning up after other methods. It is employed to remove introduced undesirable plants from around corrals, small permanent pastures and fencelines.

Cleaning haying equipment before leaving a field helps prevent undesirable plant infestations.

Control By Grazing

Control by grazing involves a combination of animal species with different dietary preferences. For example, sheep may be used to effectively control leafy spurge while goats can be utilized to keep brush in check.

Biological Control

Biological control focuses on natural enemies (predators, parasites and pathogens) of undesirable plants. It targets a single species, avoiding damage to the associated plant community. This is particularly beneficial on rangeland where a mixture of grasses and forbs is desired.

In classical biocontrol, specific host organisms from outside Canada are established on the undesirable plant and attack it on a continuous basis. Stressing the plant with several organism species may be necessary to achieve results.

The Steppe spurge flea beetle Aphthona nigriscutis is one agent used in the biological control of leafy spurge.

Researchers are determining which organisms are safe and compatible with Saskatchewan conditions to ensure that desirable plants are not attacked.

Classical biocontrol is most applicable to introduced undesirables.

For example, in the 1970s nodding thistle formed almost pure two-metre tall stands on rangeland and along roadsides in Saskatchewan. This problem was brought under control with the establishment of the seedhead weevil *Rhinocyllus conicus*, which gradually changed the thistle from a climax species to a pioneer of disturbed ground. The thistle disappears in two to three years when grass is allowed to return.

With inundative biocontrol, the organism is applied to the undesirable plant where and when it is a problem in much the same manner as a herbicide. The agent is usually a native fungus disease of natural limited effectiveness due to poor dispersal. It is grown on a nutrient medium and sprayed on the plant in a water suspension.

Inundative biocontrol is suited to controlling native undesirable plants because nothing new is added to the environment.

Mechanical Control

*See **Renovating Pasture** for a discussion of mechanical control techniques and implements.*

Chemical Control

Chemical control involves the use of herbicides. Herbicides have several advantages as a control method.

Requiring minimum labor, they are effectively used on steep slopes and stony terrain where mechanical equipment cannot operate. The cost of these applications are usually less than mechanical control treatments.

Selective chemical control of broadleaved species is possible, leaving grasses undamaged. After treatment, some living vegetation and litter covers the soil, reducing the risk of water and wind erosion.

However, consider the following disadvantages before using herbicides:

- Some undesirable plants cannot be effectively controlled while desirable forbs and shrubs may be eliminated.
- The cost of control may exceed the value of expected forage increase.
- A poor seedbed results for subsequent seeding.
- Careless use can damage off-target crops and contaminate the environment.

APPLYING HERBICIDES

Optimum spraying time occurs when the leaf blade of the target species has fully expanded, usually in June. As the growing season progresses, temperatures rise and relative humidity drops.

Aerial herbicide applications pose greater drift risks.

In response, leaves develop thicker outer cell layers, hindering herbicide entry. As well, lower relative humidity means a rapid drying rate of a herbicide drop on a leaf. There is less time for herbicide penetration, reducing its effectiveness.

The overall effectiveness of a herbicide application varies because growing and environmental conditions vary from year to year. Often a single-spray application will not provide the desired degree of control. Depending on the amount of regrowth, one to several retreatments may be required.

Legumes are damaged or killed by brush and other broadleaved plant control treatments.

Adequate control of most undesirables depends on sufficient competition from established desired forage species. Grazing management may need to be altered to give desired species the competitive edge.

There is a possibility that plants poisonous to livestock will be grazed more readily after 2,4-D treatments. Take suitable precautions when such plants are present.

The risk of herbicide drift is greater from aerial than from ground application equipment. The safest time to apply a herbicide is when temperatures are mild and relative humidity is high. Spray when wind speeds are less than 8 to 10 kmph.

Before applying any herbicide, check product labels for precautions, grazing and feeding restrictions, general use information and specific application instructions.

Not all brands of 2,4-D are registered for the same uses. Select the type of herbicide and application method that best fits the problem.

Some herbicides are not registered for general use but can be employed in spot applications as defined on product labels. The amount of pasture or rangeland that can be sprayed is usually restricted.

Apply herbicides in sufficient water for uniform and complete coverage. For root-sprouting species, apply the herbicide beyond the perimeter of the patch.

Application Methods

There are various ways to apply herbicides. Choose the one that is most applicable for the plant and site conditions.

Consider the registered product use, size of the affected area, terrain, soil conditions, timing, vegetation density and size, proximity of off-target sensitive areas and potential for spray drift.

Broadcast Foliage Treatment

The broadcast treatment is the most commonly used herbicide control method for herbaceous perennials and brush. It involves the application of a herbicide in a 110 to 220 litre water per hectare (45 to 90 litre per acre) solution using a ground sprayer, or in at least 35 litres of water or oil per hectare (15 litres per acre) using an aircraft sprayer.

Aerial applications cover large acreages quickly and are suitable for rough stony terrain. Ground application equipment permits the use of higher water volumes for better coverage and is less prone to herbicide drift.

Individual Stem-Foliage Treatment

An individual stem-foliage treatment involves the addition of a herbicide to about 1000 litres of water and applying the solution to brush foliage and stems until it runs off. The volume of spray mixture applied per hectare varies with brush height and density.

Treatments are made using a sprayer fitted with a hose assembly and a handheld spray gun, or with a backpack sprayer and extended wand. The spray is directed at the target species and away from non-target and susceptible species.

Brush after herbicide spraying.

Limit treatments to species less than 2.5 m (8 ft) in height and use only enough pressure to penetrate the target species. Although labor intensive, this provides excellent foliage coverage.

Individual Stem Treatment

Individual stem treatment is a selective application method useful for sparse tree stands, small areas and controlling undesirable plants near crops.

Applications are possible any time of the year. They often require less herbicide per hectare but are labor intensive.

There are several ways to apply herbicide to an individual stem:

1. Conventional basal bark involves spraying the lower 50 cm (20 in) of a stem to the point of run-off at the ground line.

2. Thin line requires spraying a 15 cm (6 in) wide strip around the stem 15 cm above the ground line.

3. Frill uses special injection equipment or an axe to make 5 cm (2 in) cuts at 5 cm intervals around the stem. The cut should penetrate the inner wood in a downward stroke to allow herbicide application into the frill.

4. Dormant stem involves spraying a herbicide in oil to the lower 50 cm (20 in) of the stem to ground line when vegetation is dormant.

5. Cut stump requires felling the tree and completely spraying the stump surface.

Dormant stem and cut stump treatments can be used throughout the year. Cut stump is environmentally safe, requires small amounts of herbicide per hectare, prevents brownout and eliminates drift to nearby susceptible crops.

Wiper Applicator Treatment

A wiper applicator treatment is effective when there is a visible difference in height between taller undesirable plants and shorter desirable plants. It should be possible to wipe sufficient herbicide on the undesirables to kill them without affecting herbaceous plants. This is usually the case with tree species such as aspen, but not with small shrubs like western snowberry.

Herbicide is only applied to the target plants, which allows the use of a non-selective chemical, a bigger dose of a suitable selective chemical or a more expensive chemical. Less herbicide is required because it is not wasted on non-target plants, resulting in a smaller or no effect on the surrounding environment.

The roller applicator relies on a wiping action to distribute herbicide.

Numerous wiper-applicator designs have been used in pasture brush control with mixed results. Discussions of these designs follow.

Wick Applicator

This applicator consists of a pipe, usually plastic and about 10 cm (4 in) in diameter, which acts as a reservoir for the herbicide solution. Along its length are two or three rows of fibre wicks, both ends of which penetrate into the reservoir through holes. The wicks fit tightly so no leakage of herbicide occurs, but the wicking action wets the entire fibre with herbicide.

The pipe is mounted at a suitable height on a machine which is driven through the undesirable plants. The wicks wipe herbicide on the plants, and this action replenishes the wicks as long as solution is in the reservoir.

The herbicide solution must be fairly concentrated because not much is wiped on an individual plant at one time. A solution of one-third Roundup concentrate and two-thirds water is effective on aspen poplar.

Wick applicators are unsuited to brush control. The strong raking, shredding and pulling action of woody plants removes wicks from the reservoir, or puts such stress on them that the reservoir hole seals break and herbicide is lost.

Roller Applicator

This applicator consists of a cylinder about 30 cm (12 in) in diameter with nylon carpet glued on its exterior. The cylinder, which is mounted on a frame and rotated by a hydraulic motor, is pulled or pushed through the brush.

Sufficient herbicide is sprayed or dribbled on the carpet to wet it thoroughly. The rotation of the cylinder applies a positive wiping action which spreads herbicide on the brush. As the cylinder dries, more herbicide is applied either automatically or according to operator judgment.

Concentrations of 0.5, 1.5 and 4.5 percent are used, both of Roundup and of a 4-to-1 mixture of 2,4-D (Amine 500) and Tordon 22K. Overall, a 1.5 percent solution results in fairly consistent brush control.

Even with the positive wiping action, only a small fraction of the shrub leaf area is wetted with herbicide solution. Unless brush is very dense, the major force of the roller is applied to stems and main branches. There is no action behind twigs and leaves to press them against the roller, so they pick up little herbicide.

The roller is set at a fixed height. If this is low, some damage to herbaceous vegetation results. If high, very small shrubs pass under the roller untouched, remaining to replace the killed plants in a few years. Trees taller than about 2 m (6.5 ft) are too big for the roller.

Although roller wetness can be controlled automatically, sensors may be severely damaged by the brush battering action. Manual herbicide replenishment requires good operator judgment.

If the roller rotation speed is too fast, herbicide is thrown off in a fine spray.

When the brush springs back upright after bending to pass under the roller, some herbicide is thrown off. Herbicide is also lost by the squeezing action of strong trunks and branches as they are forced under the roller.

Generally the same amount of herbicide is used as in a standard aerial application, but little is applied to non-target plants.

Roller applications risk release of residual herbicides into the environment through rainwash, leaf fall or stem translocation.

Carpet Applicator

Carpet application is another way of applying herbicide to brush.

The applicator consists of an indoor/outdoor carpet looped below a metal support frame. Spray nozzles in the carpet loops keep the carpet wet with herbicide. A dripping-wet carpet operated at a slow speed ensures adequate cover.

A solution of one-third Roundup and two-thirds water is effective in low-density stands of aspen poplar.

Carpet wipers are usually mounted on the front of a tractor and should be located at a height which allows herbicide application onto most of the highest leaves. This unit works best in brush that is 0.5 to 1.5 m (1.5 to 5 ft) in height.

PLANT TREATMENT RECOMMENDATIONS

Western Snowberry and Wild Rose

These sprouting species are difficult to control by disking or mowing. Sprouts originate from rhizomes, which can be initiated at the collar or from the root, below the height of mowing or the depth that a disk can penetrate. Several treatments are often necessary.

The top growth and, to a limited extent, the crown of western snowberry can be controlled with 2,4-D. Retreatment is required since new shoots are initiated from the collar and roots of treated plants the first and second years after a 2,4-D application.

The addition of dicamba to 2,4-D improves western snowberry control. It also controls wild rose.

A combination of mowing followed by an application of 2,4-D when western snowberry is in the 13-paired leaf stage has proven effective in Alberta. Western snowberry can be mowed in the spring and herbicide applied the same year, or it can be mowed in the fall and herbicide applied the following spring.

Pasture Sage

Control of pasture sage with 2,4-D varies from 50 to 80 percent and retreatments may be necessary.

2,4-D can be applied in the spring when pasture sage is actively growing, or in the fall if growth is still active, with retreatment the following spring. The addition of dicamba to 2,4-D improves control, but the high cost of the herbicide mixture prohibits its use.

Herbicide control of wild rose in successive years is usually necessary.

Trembling Aspen

A root-sprouting species, trembling aspen produces a dense stand of shoots after bulldozing. Fortunately, the sprouting roots are close to the soil surface and can be managed with a heavy-duty offset disk. The disk should cut below the sprouting roots, which requires 200 to 270 kg (450 to 600 lb) of pressure per blade.

Spray pasture sage during active growth periods.

2,4-D has proven an effective control of trembling aspen. At a rate of 2 kg of active ingredient per hectare, aspen control averages 80 percent. This ranges from a low of 65 percent to a high of 95 percent.

Always use the registered label rate printed on the herbicide container.

Satisfactory control is long-lasting when the aspen canopy area is one percent or less of the ground surface and the 2,4-D is applied in the spring after leaves are fully expanded. If the initial treatment proves unsatisfactory, consider a second application the following season.

During the dormant season a combination of bulldozing and 2,4-D application can be effective. Early in the growing season following clearing, new shoots sprout from the mother root. By late July or August new roots develop to support the shoots where they emerge from the mother root.

The second growing season after clearing, primary branches and leaves emerge from the one-year old shoots. The new root growth is minimal compared to shoot growth and the plant is most vulnerable to herbicide treatment. Although application of 2,4-D is effective, it can be inconsistent and retreatment may be necessary the following season.

Balsam poplar, wild rose and western snowberry often grow together with trembling aspen in the parkland belt. Balsam poplar is extremely difficult to control and western snowberry will re-encroach sooner than trembling aspen or wild rose.

A combination of dicamba and 2,4-D is necessary to control aspen, rose and snowberry. If retreatment using this combination is needed, apply the mixture two years after the initial treatment.

RENOVATING PASTURE

Seeding to perennial grass pasture begins with an evaluation of the costs and desired results of the renovation.

Try to estimate whether the returns will pay for the conversion costs compared to less disruptive alternatives. Consider all alternatives before renovating any existing pasture.

If an existing pasture contains adequate grass cover and some legumes are present, for example, the use of rotational grazing with extended rest periods will return the forage stand to adequate production. Fertilizer use enhances this process.

The following variables have a major impact on both conversion costs and returns:

- Landform, including amount of stones. Stones may break machinery.
- Soil characteristics, including salinity. Cultivation may bring shallow salt deposits to the surface, leaving soils prone to wind and water erosion.
- Amount and quality of water, both for livestock and vegetation.
- Type and amount of both woody and herbaceous vegetation. Existing vegetation may be difficult to kill and will re-establish from seed stored in the soil. On the other hand, land which has been growing annual crops for many years does not usually cause major difficulties when converting it to forage crops. However, forages have small seeds and may have slow-growing seedlings compared to annual crops.
- Current custom rebreaking costs. Tree and brush removal is expensive.

Costs Versus Returns Guide

Breaking and reseeding may be unnecessary if fertilizer is used. However, if brush regrowth is the major reason for rebreaking, the costs may be a good investment.

Nitrogen is often the limiting factor in forage production, especially if no nitrogen-fixing plant such as alfalfa is in the sward. Fertilizing a tame forage with nitrogen almost always increases production even in dry years.

However, the question is, will the addition of nitrogen fertilizer pay? The increased grass and undesirable plant production usually does not equal fertilizer and application costs. Consider these costs, the cost of alternative pasture and expected beef production before applying fertilizer.

The reseeding cost may be warranted if crested wheatgrass or meadow bromegrass

is being added to the rotational grazing plan for early spring grazing.

The following guide is useful in assessing whether to proceed with pasture renovation given various circumstances.

Choose those statements that best describe your land and list the number beside each statement you select. Then total these numbers. The larger the total the more difficult the renovation, with a lesser chance of a satisfactory return on your investment.

Landform

1. Land uniformly flat to gently rolling.
2. Land hilly to steeply rolling.
4. Wet, swampy and many sloughs, which limit the time of cultivation and area cultivated.
8. Many gullies and coulees, making cultivation difficult, limited in extent or impossible.
16. Stony enough to cause much machinery wear and breakdown.

Soil Type

1. Heavy loam.
2. Loam.
4. Heavy clay.
8. Sandy or light loam.
16. Sand.

Soil Zone

1. Black.
2. Grey wooded.
4. Dark brown.
8. Light brown.

Soil Salinity

1. No salinity.
2. Some salinity below the surface.
4. Saline patches at the surface.
8. Extensive saline areas.
16. The whole area is saline.

Stock Water

1. Plenty of water almost everywhere all summer.
2. One or two good water sources per quarter.
4. One water source per section.
8. Very few water sources anywhere.

Water Quality

1. Good water.
2. Fair water.
4. Very poor water.

Woody Plants

1. Few woody plants of any size.
2. Bluffs or small patches of tall (over 2 m) trees.
4. Large areas of shrubs or scrub trees (less than 2 m).
8. Mature trees (5 to 15 m) cover much of the area.

Herbaceous Plants

1. Large quantities or areas of poisonous plants.
2. Large quantities or areas of unpalatable plants.
4. Large quantities or areas of unproductive but edible weeds.
8. Small patches of unpalatable or poisonous plants.
16. Plant selection is satisfactory but productivity is low.
32. No major problems (renovation is then not economical to undertake).

Evaluation is the first step in a pasture renovation.

Land Clearing

Bulldozing is used most often to clear trees.

A crawler tractor (75 kW/100 hp or greater unit) equipped with a heavy-duty push blade is usually employed in the spring to clear and then pile trees into long windrows 30 to 60 m (100 to 200 ft) apart. After a minimum of one growing season, the wood is dry enough to burn. Remaining debris is repiled and burnt.

Brush regrowth is a good reason to rebreak pasture.

When clearing occurs in the summer, trees are uprooted and top soil is piled with the tree roots. The removal of top soil, however, is environmentally unacceptable in areas with a thin soil layer. Large piles of soil and tree parts make excellent sites for undesirable plant invasions such as Canada thistle and absinth.

Bulldozing trees when the soil is frozen in early winter cuts most trees off at ground level, leaving the soil in place. This operation usually requires a V-shaped cutter mounted on the front of a large (100 kW/135 hp or greater) bulldozer. Later the trees are piled in windrows about 60 m (200 ft) apart and burned.

Although environmentally more acceptable, winter clearing leaves the roots of sprouting species intact and regrowth may be rapid.

Breaking or Rebreaking

Newly cleared or old depleted land is commonly broken using heavy-duty 11 cm (28 in) or greater serrated tandem offset disk plows. This equipment, pulled with a bulldozer or large four-wheel drive tractor, has two gangs to move soil in opposite directions. This eliminates the twice-over operation required of single-disk plows.

Bulldozing is a familiar land clearing method in Saskatchewan.

Offset disks leave considerable mulch at or near the soil surface, slowing soil erosion. They are not suited for stony land or where large brush is present.

Crawler tractor pulling a heavy breaking disk.

Disking does not selectively clear land. Both undesirable and desirable plants are killed.

Renovation generally involves spiking a sod-bound pasture 10 to 12 cm (4 to 5 in) deep. The field may be 'ripped' once or twice.

Workdown

Following breaking of the old pasture stand or new land, additional tillage is required to control shallow-rooted species and prepare seedbeds. The more tillage the better, since a well-worked and firm seedbed is necessary for good seed establishment.

One workdown method uses a heavy tandem serrated farm disk. A heavy log or railway steel pulled behind the tandem disk helps break up the sod clumps and level the land.

Rotary mowers, which have one or more horizontally rotating blades, can cut plants 10 to 30 cm (4 to 12 in) above the ground. Lightweight mowers are often employed to cut herbaceous weeds. Heavy-duty mowers cut woody plants up to 20 cm (8 in) in diameter.

Mowers are effective on tall-growing plant species but ineffective on low-growing and semi-prostrate undesirables. For example, foxtail barley or scentless chamomile can flower and set seed a few weeks after mowing.

To prevent seed set, always carry out multiple mowing treatments starting early in the season. A single-rotary mower treatment is ineffective against root sprouting. Multiple mowings during the year and over several years work provided they are timed to reduce underground food supplies.

Rotary mowers are not suitable for rough stony terrain. However, they usually improve the appearance of undesirable plant areas. They also act to scatter plant debris, preventing the smothering of new growth.

Seeding

Reseed old depleted pastures after fields have been well-worked and the old sod clumps are dead. If the area is reseeded too soon after breaking, the new stand reverts back to the original plant species within a few years.

Even if the sod clumps are dead, the ground contains viable seeds from the previous grass stands. These seeds germinate and compete with the new introduced species.

One way to reduce this problem is to seed spring or winter annual cereals such as oats, rye or wheat for one to three years. This helps clear the seedbed of the previous forage stand.

Another method is to spring-seed fall rye and sweetclover. This stand can be rotationally grazed during the summer and early fall. With a fall rest period the fall rye and, especially the sweetclover, provide excellent grazing the second year.

Mowing is most effective on plants up to 30 cm.

The area is worked down with heavy-duty disks in the fall prior to freeze-up. Moisture conditions are critical for deep tillage penetration. The following spring the area is seeded to forage as early as possible to take advantage of spring moisture.

Direct Seeding (Sod-Seeding)

Research to date concerning forage seeding without cultivation shows that while the existing vegetation can be killed with a chemical application, the seedbank in the soil is not affected and re-establishes along with the seeded forages.

Alfalfa can be established or its presence increased in pastures in the grey wooded soil zone, sometimes by seeding directly into the existing sod, but more reliably by seeding into a previously killed strip about 30 cm (12 in) wide.

In wet years, spraying and seeding in one operation is successful, but more uniform results are obtained if the sod is killed in spring and the alfalfa is seeded late the following fall.

In the dark brown soil zone, trials have produced a satisfactory stand of alfalfa about half of the time. Good stands are rarely obtained in the light brown soil zone.

Seed Drills

There are very few seed drills designed especially for seeding in rough and stony pastures. The ideal drill is heavy duty, and has independently suspended seeding disks with depth-control devices to limit penetration to about 2.5 cm (1 in).

Packing wheel attachments, or cover chains dragged behind the drill, are also essential. A well-packed seedbed improves forage establishment.

Spacings of about 30 cm (12 in) provide adequate pasture stands in the north, while 60 to 90 cm (24 to 36 in) spacings are suitable in the brown soil zones. These spacings also allow small rocks to pass between the seeding disks.

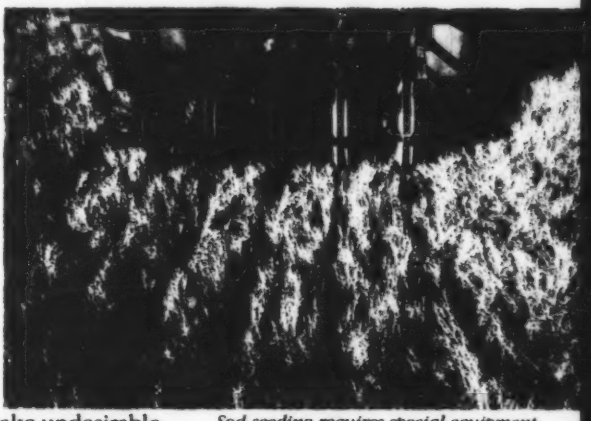
Broadcasting is usually not recommended because of uneven seed placement and poor seed cover.

Separate seedboxes for grass seed and legumes are required. Grass seedboxes must have agitators for the grass seeds and smooth-flowing, accurate metering systems.

The Prairie Farm Machinery Institute in Humboldt and Portage la Prairie, as well as the Agriculture Canada Research Stations at Melfort and Swift Current, have evaluated several seed drills. These reports are available upon request.

Companion Crops

A companion crop provides grazing, hay or grain in the year of forage establishment, helps shield the land from wind and water erosion, and offers some protection to the forage seedling against extreme weather. Annual cereal stubble also has the added benefit of trapping snow.



Sod-seeding requires special equipment.

On the other hand, companion crops compete with the forage seedlings for water, light and nutrients. They also make undesirable plant control more difficult because suitable herbicides may not be available that can be used on both companion crop and forage.

Another problem is forage yield is less the year following the seeding of a companion crop. This yield loss may continue for several more years if establishment conditions are poor.

Annual cereals can be used for pasture, hay or allowed to mature, depending on the grower's requirements and judgment of seasonal needs. Spring wheat is the least competitive, followed by oats and barley.

The seeding rate of a cereal companion crop can be adjusted according to its purpose. For providing protection from the elements, a very light seeding rate is satisfactory. Where a crop is desired, half the normal seeding rate is often recommended. This affects companion crop yield little while competing less with the forage seedlings.

Canola, preferably the Polish varieties, is often used as a companion crop but is more competitive than the cereals.

No companion crop seeding rate allows both the crop and forage to achieve maximum production.

Careful grazing of companion crops will not damage the underseeded forage

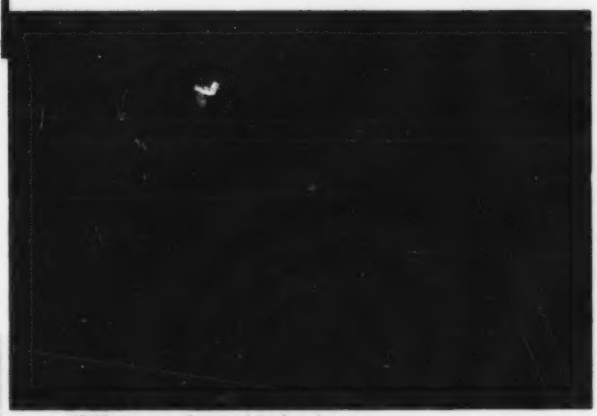
A rangeland seeder with dragging chains.

Alfalfa, Russian wildrye and companion crop stubble.

provided the soil is not so wet that the surface cannot bear the weight of animals. A short intensive graze is preferable to a long grazing period. The companion crop should not be grazed to such a degree that the forage seedlings are eaten off.

Forage Varieties

Consult ***Forage Crop Recommendations*** *and* ***Forage Manual*** *for more information on Saskatchewan forage varieties. They are available from Saskatchewan Rural Development and Saskatchewan Agriculture and Food offices.*



Alfalfa is one of several Saskatchewan forage varieties.

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APPENDIX I

IMPORTANT SASKATCHEWAN RANGE PLANTS

GRASSES

Alkali cord grass	Spartina gracilis
Awned wheatgrass	Agropyron subsecundum
Big bluestem	Andropogon gerardii
Blue grama	Bouteloua gracilis
Canada bluegrass	Poa compressa
Canada wildrye	Elymus canadensis
Canby bluegrass	Poa canbyi
Cotton grass	Eriophorum spp.
Desert salt grass	Distichlis stricta
Fowl bluegrass	Poa palustris
Fowl manna grass	Glyceria striata
Foxtail (wild) barley	Hordeum jubatum
Fringed brome	Bromus ciliatus
Green foxtail	Setaria viridis
Green needlegrass	Stipa viridula
Hairy wildrye	Elymus innovatus
Hooker's oatgrass	Helictotrichon hookeri
Indian rice grass	Oryzopsis hymenoides
June grass	Koeleria cristata
Kentucky bluegrass	Poa pratensis
Little bluestem	Schizachyrium scoparium
Marsh reed grass (blue joint)	Calamagrostis canadensis
Mat muhly	Muhlenbergia richardsonis
Narrow reed grass	Calamagrostis neglecta
Needle-and-thread	Stipa comata
Northern awnless brome	Bromus pumpellianus
Northern reed grass	Calamagrostis inexpansa
Northern wheatgrass	Agropyron dasystachyum
Nuttall's salt-meadow-grass	Puccinellia nuttalliana
Parry oatgrass	Danthonia parryi
Pine grass	Calamagrostis rubescens
Plains muhly	Muhlenbergia cuspidata
Plains reed grass	Calamagrostis montanensis
Prairie cord grass	Spartina pectinata
Porcupine grass	Stipa spartea
Purple oatgrass	Schizachne purpurascens
Reed canary grass	Phalaris arundinacea
Rough fescue	Festuca scabrella
Rough hair grass	Agrostis scabra
Sand dropseed	Sporobolus cryptandrus
Sand grass	Calamovilfa longifolia
Sandberg bluegrass	Poa sandbergii
Sheep fescue	Festuca ovina
Side-oat grama	Bouteloua curtipendula
Slender wheatgrass	Agropyron trachycaulum
Slough grass	Beckmannia syzigachne
Sweet grass	Hierochloe odorata
Switch grass	Panicum virgatum
Timber oatgrass (intermediate)	Danthonia intermedia
Tall manna grass	Glyceria grandis
Tufted hair grass	Deschampsia caespitosa
Western (northern) porcupine grass	Stipa curtiseta
Western wheatgrass	Agropyron smithii
White-grained rice grass	Orysopsis asperfolia
Whitetop (spangletop)	Scolochloa festucacea

GRASSLIKE PLANTS

Awned sedge	Carex atherodes
Baltic rush	Juncus balticus
Beaked sedge	Carex rostrata
Graceful sedge	Carex praegracilis
Low sedge	Carex eleocharis
Sun-loving sedge	Carex pensylvanica
Thread-leaved sedge	Carex filifolia

FORBS

Absinth	Artemisia absinthium
American vetch	Vicia americana
Baneberry	Actaea rubra
Biennial wormwood	Artemisia biennis
Bunchberry	Cornus canadensis
Cactus	Opuntia
Canada thistle	Circium arvense
Canada anemone	Anemone canadensis
Colorado rubberweed	Hymenoxys richardsonii
Cow parsnip	Heracleum lanatum
Cream coloured vetchling	Lathyrus ochroleucus
Crocus	Anemone patens
Curled Dock	Rumex crispus
Dandelion	Taraxacum offincinale
Dense club-moss	Selaginalla densa
Diffuse knapweed	Centaurea diffusa
Dotted blazing star	Liatris punctata
Everlasting (pussy-toes)	Antennaria spp.
False Solomon's-seal	Smilacina stellata
Field bindweed	Convolvulus arvensis
Fireweed	Epilobium angustifolium
Fleabane	Egigeron spp.
Gaillardia	Gaillardia aristida
Goatsbeard	Tragopopgon dubius
Golden bean	Thermopsis rhombifolia
Goldenrod	Solidago spp.
Gumweed	Grindelia squarrosa
Hairy golden aster	Heterotheca villosa
Harebell (bluebell)	Campanula rotundifolia
Hoary cress	Cardaria spp.
Indian breadroot	Psoralea esculenta
Indian paintbrush	Castilleja spp.
Kochia	Kochia scoparia
Leafy spurge	Euphorbia esula
Meadow rue	Thalictrum spp.
Milk-vetches	Astragalus spp.
Milkweed	Asclepias spp.
Moss phlox	Phlox hoodii
Northern bedstraw	Galium boreale
Pale comandra	Comandra pallida
Perennial sow thistle	Sonchus arvensis
Poverty weed	Iva axillaris
Prairie coneflower	Ratibida columnifera
Prairie sage	Artemisia ludoviciana
Purple prairie clover	Petalostemon purpureum
Purple vetchling/peavine	Lathyrus venosus
Red samphire	Salicornia rubra
Russian knapweed	Centaurea repens
Scarlet mallow	Malvastrum coccineum
Scentless chamomile	Matricaria maritima
Silverleaf psoralea	Psoralea agrophylla
Skeleton weed	Lygodesmia juncea
Smooth aster	Aster laevis

Spiny ironplant	Haplopappus spinulosus
Sweet broom	Hedysarum spp.
Tansy	Tanacetum vulgare
Three-flowered avens	Geum triflorum
Toadflax	Linaria vulgaris
White prairie aster	Aster falcatus
Wild licorice	Glycyrrhiza lepidota
Wild red raspberry	Rubus idaeus
Wild sarsaparilla	Aralia nudicaulis
Yarrow	Achillea spp.
Yellow avens	Geum allepicum

SHRUBS AND TREES

Alder	Alnus spp.
Balsam poplar	Populus balsamifera
Bearberry	Arctostaphylos uva-ursi
Broomweed (broom snakeweed)	Gutierrezia sarothrae
Canada buffaloberry	Shepherdia canadanesis
Chokecherry	Prunus virginiana
Creeping juniper	Juniperus horizontalis
Dry ground cranberry	Vaccinium vitis-idaea
Gooseberry	Ribes spp.
Greasewood	Sarcobatus vermiculatus
Hawthorn	Crataegus spp.
Nuttall's atriplex	Atriplex nuttallii
Pasture (fringed) sage	Artemisia frigida
Pincherry	Prunus pensylvanica
Rabbitbrush	Crysothamnus nauseosus
Red-osier dogwood	Cornus stolonifera
Rose	Rosa spp.
Saskatoonberry	Amelanchier alnifolia
Shrubby cinquefoil	Potentilla fruticosa
Silver sagebrush	Artemisia cana
Skunkbush	Rhus trilibata
Spreading dogbane	Apocynum androsaemifolium
Trembling aspen	Populus tremuloides
Twinning honeysuckle	Lonicera glaucescens
Western snowberry	Symphoricarpos occidentalis
Willow	Salix spp.
Winterfat	Ceratoides lanata
Wolf-willow (silverberry)	Elaeagnus commutata

POISONOUS

Arrow-grass	Triglochin spp.
Death camas	Zygadenus gramineus
Horsetail	Equisteum spp.
Leafy spurge	Euphorbia esula
Locoweed	Oxytropis spp.
Narrow-leaved milk-vetch	Astragalus pectinatus
Silvery lupine	Lupinus argenteus
Two-grooved milk-vetch	Astragalus bisulcatus
Water hemlock	Cicuta spp.

PLANT CHARACTERISTICS

Name of Plant	Type of Plant				Life Span			Origin of Plant		Season of Growth		Grazing Response			Forage Value			
	Grass	Grasslike	Shrub	Forb	Annual	Biennial	Perennial	Native	Introduced	Cool	Warm	Decreaser	Increaser	Invader	Good	Fair	Poor	Poisonous
Alkali cord grass	•						•	•			•	•					•	
Arrow-grass				•			•	•		•			•				•	•
Awned wheatgrass	•						•	•		•		•			•			
Baltic rush		•					•	•		•			•				•	
Blue grama	•						•	•			•		•		•			
Bromeweed							•	•			•		•				•	
Canada bluegrass	•						•		•	•				•	•			
Canada wildrye	•						•	•		•		•			•			
Canby bluegrass	•						•	•		•		•			•			
Chokecherry			•				•	•		•		•				•		•
Dandelion				•			•		•	•				•			•	
Death camas				•			•	•		•			•				•	•
Dense club-moss				•			•	•					•				•	
Desert saltgrass	•						•	•			•		•				•	
Everlasting				•			•	•		•			•					
Fireweed				•			•	•		•			•			•		
Foxtail barley	•						•	•		•			•				•	
Fringed brome grass	•						•	•		•		•				•		
Geranium (sticky)				•			•	•		•		•			•			
Goatsbeard				•		•			•	•				•			•	
Greasewood			•				•	•			•		•			•		•
Green needlegrass	•						•	•		•		•			•			
Gumweed				•		•		•			•		•				•	
Hairy wildrye	•						•	•		•			•			•		
Hooker's oatgrass	•						•	•		•		•				•		
Indian rice grass	•						•	•		•		•			•			
Junegrass	•						•	•		•			•		•			
Kentucky bluegrass	•						•		•	•				•	•			
Little bluestem	•						•	•			•	•					•	
Loco-weed				•			•	•		•			•				•	•
Marsh reed grass	•						•	•		•		•				•		
Moss phlox				•			•	•		•			•				•	

APPENDIX II

Name of Plant	Type of Plant				Life Span			Origin of Plant		Season of Growth		Grazing Response			Forage Value			
	Grass	Grasslike	Shrub	Forb	Annual	Biennial	Perennial	Native	Introduced	Cool	Warm	Decreaser	Increaser	Invader	Good	Fair	Poor	Poisonous
Narrow-leaved milk-vetch				•			•	•		•			•				•	•
Needle-and-thread	•						•	•		•			•		•			
Northern wheatgrass	•						•	•		•		•			•			
Nuttall's atriplex			•				•	•			•	•			•			
Parry oatgrass	•						•	•		•			•		•			
Pasture sage			•				•	•			•		•				•	
Plains muhly	•						•	•			•		•			•		
Prairie cord grass	•						•	•			•	•			•			
Prairie sage				•			•	•			•		•			•		
Rose			•				•	•		•			•				•	
Rough fescue	•						•	•		•		•			•			
Sandberg bluegrass	•						•	•		•			•		•			
Sand dropseed	•						•	•			•		•			•		
Sand grass	•						•	•			•	•				•		
Saskatoonberry			•				•	•		•		•				•		
Shrubby cinquefoil			•				•	•		•			•				•	
Silver sagebrush			•				•	•			•		•			•		
Slender wheatgrass	•						•	•		•		•			•			
Slough grass	•				•			•		•			•			•		
Thread-leaf sedge		•					•	•		•			•		•			
Timber oatgrass	•						•	•		•			•		•			
Tufted hair grass	•						•	•		•		•			•			
Two-grooved milk-vetch				•			•	•		•			•				•	•
Vetch				•			•	•		•		•			•			
Vetchling				•			•	•		•		•			•			
Western porcupine grass	•						•	•		•		•			•			
Western snowberry			•				•	•		•			•				•	
Western wheatgrass	•						•	•		•			•		•			
Willow			•				•	•		•		•				•		
Winterfat			•				•	•		•		•			•			
Yarrow				•			•	•		•			•				•	

APPENDIX III

GRAZING SYSTEMS SUMMARY

System	Management Input	Basis	Means of Protecting Range Ecosystem	Important Points
Seasonlong	Low	Allow livestock to graze freely.	Reduce stocking rates; graze during plant dormancy	Maximum livestock selectivity.
Deferred-Rotation	Moderately Low	Defer grazing until plant has completed all or part of life cycle.	Improved plant vigor; better animal distribution.	Not flexible; slow improvement if more plants necessary.
Rest-Rotation	Moderate	Grazing deferment plus yearlong rest.	Improved plant vigor; better animal distribution; better opportunity for seedling establishment than seasonlong or deferred rotation.	More flexible than deferred; slow improvement if more plants necessary.
Short-Duration	High	Use animal-animal competition to manipulate selectivity. Fairly rigid schedule.	Uniform forage use lessens plant-plant competition; guaranteed rest period rapidly improves plant vigor; more animal impact than seasonlong, deferred and rest-rotation.	Animal performance very good if grazing period is short.
Time-Controlled	Very High	Use high animal densities and timed moves to utilize all forage plants and prevent regrazing of individual plants. Grazing periods vary.	Prevention of regrazing; sufficient recovery time; opportunity to manipulate animal impact.	Flexible; requires at least 2-3 au/ac to achieve animal impact; must be monitored daily; leave adequate leaf area.

APPENDIX IV

IMPORTANT RANGELAND PLANNING ACTIVITIES

- Obtain aerial photos and topographic maps.
- Mark improvements, soil types and potential hazards.
- Map vegetation zones including areas of overuse, underuse and range condition. Detail past use.
- Prepare an inventory of forage resources. Match forage supply to demand and identify where shortages are occurring.
- Record on a calendar information related to when and where livestock are moved, grazing duration, livestock numbers and special wildlife considerations. Detail planned versus actual information.
- Record weights at the beginning and end of the grazing season.
- Collect plant tissue samples periodically during the season to determine forage quality.
- Take soil samples if fertilizers are used.
- Monitor changes in range condition and determine biomass production.
- Prepare an inventory of manpower, equipment and finances.
- Draw up an overall workplan for the year.
- Set goals, evaluate them and redefine priorities.

APPENDIX V

HERBICIDE AND APPLICATION METHODS FOR SASKATCHEWAN

Check the product label for rate of application, grazing and feeding restrictions.

SPECIES	TREATMENT	HERBICIDE
Absinth	Foliage	2,4-D LV ester
	Spot	Roundup
Asters	Foliage	2,4-D LV ester
	Spot	Banvel + 2,4-D LV ester or amine
Biennial Wormwood	Foliage	2,4-D LV ester
Balsam Poplar	Stem-foliage	Banvel + 2,4-D LV ester or amine
	Stem-foliage	Roundup
Canada Thistle	Foliage	2,4-D LV ester, Banvel
		Banvel + 2,4-D ester or amine 500
	Spot	Amitrol-T, Roundup, Tordon
Chokecherry	Foliage	2,4-D LV ester
Curled Dock	Spot	Roundup
Diffuse Knapweed	Spot	Banvel, Tordon 22K
Field Bindweed	Foliage	2,4-D LV ester, Banvel
		Banvel + 2,4-D LV ester or amine
	Spot	Roundup, Tordon 22K
Gumweed	Foliage	2,4-D LV ester
Hoary Cress	Spot	Amitrol-T, Roundup
Leafy Spurge	Foliage	2,4-D LV ester
	Spot	Tordon 22K
Locoweeds	Foliage	2,4-D ester
Lupines	Foliage	2,4-D ester
Milk-Vetches	Foliage	2,4-D ester
Milkweeds	Spot	Amitrol-T
Pasture Sage	Foliage	2,4-D LV ester
	Spot	Banvel, Tordon 22K
Perennial Sow-Thistle	Foliage	2,4-D LV ester, Banvel,
		Banvel + 2,4-D ester
	Spot	Amitrol-T, Roundup, Tordon 22K
Poverty Weed	Foliage	2,4-D LV ester
	Spot	Banvel, Tordon 22K

Prairie Sage	Foliage	2,4-D LV ester
Pussy-Toes (Everlasting)	Foliage	2,4-D LV ester
Russian Knapweed	Spot	Tordon 22K
Saskatoonberry	Foliage	2,4-D LV ester
Scentless Chamomile	Spot	Tordon 22K
Toadflax	Spot	Tordon 22K
Trembling Aspen	Foliage	Banvel + 2,4-D LV ester
	Foliage	2,4-D LV ester
	Stem-foliage	Banvel + 2,4-D LV ester or amine
	Stem-foliage	Roundup
Western Snowberry	Foliage	2,4-D LV ester, Banvel+2,4-D LV
	Stem-foliage	Banvel + 2,4-D ester or amine, Roundup
Roses	Foliage	Banvel + 2,4-D LV ester or amine
	Stem-foliage	Banvel + 2,4-D LV ester or amine
Willows	Foliage	2,4-D LV ester
	Stem-foliage	Roundup
Wolf-Willow	Stem-foliage	Banvel + 2,4-D LV ester or amine

GLOSSARY

These definitions are compiled from the Society for Range Management publication ***Glossary of Terms Used in Range Management,*** *2nd Ed. 1974, and* ***North American Range Plants,*** *3rd Ed., 1986.*

Acute. A grass blade or ligule which is abruptly sharp pointed.

Animal unit month (AUM). The amount of forage consumed by a 1,000-pound (450 kg) cow, with or without calf, in one month. Traditionally a figure of 840 pounds of dry matter per month (28 pounds per day) has been considered the norm. This 840-pound figure takes losses to trampling, dunging, urinating and insects in account.

Auricle. An ear-like lobe or appendage at the base of the leaf blade of certain grasses.

Awl-shaped. Narrow and sharp pointed.

Bunchgrass. A growth habit of forming a bunch or a clump.

Carrying capacity. A measure of a range type's ability to produce a sustained forage yield, and thus to meet the requirements of the grazing animal. Carrying capacity is based on a safe utilization level based on mean annual forage production and the plant community's tolerance of grazing pressure. Carrying capacity does not fluctuate yearly in response to forage production and stocking rates, but does fluctuate with weather conditions.

Ciliate. Fringed with hairs on margin.

Climax. The highest ecological level of plant community development capable of perpetuation under prevailing climatic and soil conditions. A climatic climax is one determined by climate. An edaphic climax is one determined by soil.

Decreaser. Plant species of the original or climax vegetation that will decrease in relative amount with continued overuse.

Degree of use. The proportion of a current year's forage production that is consumed and/or destroyed by grazing animals.

Ecology. The study of the interrelationships of organisms with their environment.

Ecosystem. Organisms together with their abiotic environment, forming an interacting system, inhabiting an identifiable space.

Ecotone. A transition area of vegetation between two communities, having characteristics of both kinds of neighboring vegetation as well as characteristics of its own. Varies in width depending on site and climatic factors.

Ecotype. A locally adapted population of a species which has a distinctive limit of tolerance to environmental factors.

Edaphic. Refers to soil.

Grazing cell. An area of land planned for grazing management purposes.

Grazing system. The manipulation of livestock in a planned manner in order to accomplish a desired goal.

Herbivore. An animal which feeds on plants.

Increaser. Plant species of the original vegetation that increase in relative amount, at least for a time, under overuse.

Invader. Plant species that were absent in undisturbed portions of the original vegetation of a specific range site and will encroach following disturbance or continued overuse.

Ligule. The appendage, membrane or ring of hairs at the junction of the leaf sheath and blade.

Membranous. Thin, opaque, not green; like a membrane.

Obtuse. Shape of an apex, with an angle greater than 90 degrees.

Paddock. A division of land within a grazing cell.

Palatability. The relish with which a particular species or plant part is consumed by an animal.

Pasture. A grazing unit seeded to tame forages.

Phenology. The study of periodic biological phenomenon such as flowering and seed-set, especially relating to climate.

Preference. A selective grazing response exhibited by animals when confronted with choices.

Proper use factors (PUFS). The percentage of utilization (for a forage species or range type) deemed as acceptable to improve or maintain range condition.

Pubescent. Covered with short soft hairs.

Quadrat. In strict terms, a square sample unit or plot. In practical terms, quadrats vary in size and shape according to the plant community being sampled.

Range. Land that supports a cover of herbaceous or shrubby vegetation useful for grazing animals.

Range condition. The current productivity of a range relative to what that range is naturally capable of producing. A measure of the health of the range.

Range improvement. Any structure or practice designed to improve range condition or facilitate better range utilization.

Range inventory. A list of resources of a management area, including range sites, range condition and trend, degree of use, stocking rates, physical improvements and natural features.

Range readiness. The defined stage of plant growth at which grazing may begin under a specific management plan.

Range site. A distinctive kind of rangeland, which in the absence of abnormal disturbance and physical site deterioration, has the potential to support a native plant community typified by an association of species different from that of other sites. This differentiation is based upon significant differences in kind or proportion of species, or total productivity.

Range trend. The direction of change in range condition, whether improving, deteriorating or remaining stable.

Rhizome. An underground stem with nodes, scale-like leaves and internodes.

Ruminant. A hoofed mammal that chews the cud.

Sod grass. Stoloniferous or rhizomatous grass which forms a sod or turf.

Stipules. Leaf-like appendages occurring in pairs on each side of leaf base.

Stocking rate. The number of animals on a unit area of land during a month or a grazing season. This is usually expressed in AUMS/acre or AUMS/quarter section. For example, a quarter section of land that grazes 10 cows for four months has a stocking rate of 0.25 AUMS/acre or 40 AUMS/quarter.

Stocking density. The number of animals on a given area of land at any moment in time. For example, an acre of land grazing 50 head of cows for one day each year would have a stock density of 50 head per acre on that day, but a stocking rate of 1.66 AUMS/acre.

Succession, plant. The process of vegetational development wherebyan area becomes successively occupied by different plant communities of higher ecological order.

Transect. A cross section of an area used as a sample for recording, mapping, or studying vegetation.

Truncate. Ending abruptly; appearing to be cut off at the end.

Watershed. A total area of land above a given point on a waterway that contributes runoff water to the flow at that point. A major subdivision of a drainage basin.